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ASSESSMENT OF HEAT RECOVERY VENTILATOR OPERATION AND PERFORMANCE IN ALBERTA

July 1990

Prepared by

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Inc.

The views and conclusions expressed and the recommendations made in this report are entirely those of the author and should not be construed as expressing the opinions of Alberta Municipal Affairs.

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FOREWORD

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EXECUTIVE SUMMARY

The trend towards more airtight, energy efficient houses has led to the increased use of heat recovery ventilators (HRVs). These devices are currently being installed in approximately 4% of new homes in Alberta and 10% of new homes in Canada and their use is expected to increase. Although great improvements have been made in ventilation technology over the past 10 years, problems are still being reported in the field which raise questions about the effectiveness of heat recovery ventilation strategies in providing good indoor air quality.

The objectives of this project were to identify operating and performance problems with HRV systems and to work with the major manufacturers to develop and test practical and cost effective solutions to these problems. In order to accomplish these objectives, Howell-Mayhew Engineering enlisted the assistance of Conservation Energy Systems, the vanEE manufacturer, and Nutech Energy Systems, the Lifebreath manufacturer.

The study concentrated on ventilation strategies in Alberta using vanEE and Lifebreath HRVs and comprised three components:

a) a survey of regulatory agencies, research organizations, manufacturers and distributors to determine concerns within the industry;
b) a survey of builders, installers and homeowners to determine the extent of problems occurring in the field; and
c) a field investigation to study problems first-hand and to test potential solutions.

The problems that were encountered fell into two broad categories: those associated with the components of the system, and those associated with system installation. It was found that the component problems are continually being addressed by the manufacturers who have made significant improvements to their HRVs, HRV accessories and support documentation. These are discussed in detail in the report.

Most of the ventilation system problems that occur, however, result directly from poor or incomplete installations carried out by unqualified tradespeople or contractors that do not have a clear understanding of ventilation principles and have not kept abreast of technical advancements in this field. The study concluded that, if it is recognized and accepted that natural ventilation is not sufficient to ensure acceptable indoor air quality during the winter

heating season, and if it is also recognized that proper ventilation will require expert installers and designers as well as knowledgeable inspection authorities, then education and training must become a greater priority within the industry.

In addition, if installation contractors are not ready to accept the responsibility of ensuring that their ventilation systems are properly installed, commissioned and capable of providing good indoor air quality, then steps must be taken to regulate the installation of these systems.

Finally, as concerns are addressed, it is very important that a significant effort be made to provide the owners of existing ventilation systems with information that will allow them to verify the operation of their systems. This will, of course, require trained service personnel to address homeowner concerns.

1.0 INTRODUCTION

1.1 Background

The trend to more airtight, energy efficient houses has led to the increased use of heat recovery ventilators (HRVs). These units are designed to:

a) provide ventilation air in a manner that will not create unacceptable pressure imbalances across the building envelope; and

b) transfer heat from the warm, outgoing exhaust air to the cold, incoming ventilation air.

HRVs are now being installed in approximately 4% of new homes in Alberta and in approximately 10% of new homes across Canada. Their use is expected to increase due to homeowner demand and regulatory requirements which require more effective ventilation systems.

The R-2000 Program, an energy efficient housing initiative administered by the Canadian Home Builder's Association, spurred the development of HRV products and, although great improvements have been made by the major manufacturers, problems are still being reported which raise questions concerning the effectiveness of heat recovery ventilation strategies in providing adequate indoor air quality.

1.2 Objectives and Scope of Work

The objectives of this project were to:

a) identify operating and performance problems with HRV systems; and

b) develop and test practical and cost effective solutions to these problems.

In order to accomplish these objectives, Howell-Mayhew Engineering (HME) enlisted the assistance of the two manufacturers with the largest number of installed HRVs in Alberta - Conservation Energy Systems (CES), the manufacturer of the vanEE units, and Nutech Energy Systems (Nutech), the manufacturer of the Lifebreath units. As a result, only houses with vanEE or Lifebreath HRVs were investigated.

2.0 INDUSTRY SURVEY OF VENTILATION CONCERNS

2.1 Regulatory Agencies

As new building techniques and products reduce air leakage through the building envelope, and new space and water heating technology reduces the amount of air which is exhausted from the house, concerns have been raised throughout the industry regarding indoor air quality and the provision for an adequate supply of ventilation air. It is recognized and accepted that natural ventilation is not sufficient to ensure acceptable indoor air quality during the winter heating season.

In 1985, the National Building Code (NBC) attempted to address these concerns by requiring that dwelling units be provided with a mechanical ventilation system capable of providing at least one-half air change per hour (ACH). In addition, it required that provision be made for the introduction of make-up air from the exterior. Unfortunately, due to a lack of understanding of basic ventilation issues, these requirements led to uncertainty among installers, designers and inspectors as to how to ensure compliance with these regulations.

The Canadian Standards Association (CSA) responded by establishing the Technical Committee on Ventilation Requirements for Housing to address the need for a national set of residential ventilation requirements. As a result of the work of this committee, the CSA Preliminary Standard F326.1, *Residential Mechanical Ventilation Requirements* was published in January 1989 and describes a set of ventilation requirements for single-family dwellings. It forms the first part of a series of Standards for residential ventilation. The CSA Preliminary Standard F326.2, *Residential Mechanical Ventilation System Installation Requirements* was published in December 1989 and defines the installation requirements for ventilation systems intended to conform with CSA Preliminary Standard F326.1. An additional standard under development is the CSA Standard F326.3, *Residential System Compliance Methods*. A training manual will also be prepared to provide the basis for teaching the design and installation of ventilation systems.

In addition to the work initiated by CSA, the Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI), developed a course to enable industry members to understand the principles of good ventilation design and installation and the requirements of the F326 standards. HRAI recognizes that proper ventilation will require expert installers and designers as well as knowledgeable inspection authorities. Each year, this course is presented in selected centers across Canada.

Proposed changes to the 1990 NBC will make provisions for mechanical ventilation systems designed to operate on a continuous basis, such as HRV systems. It has been proposed that such units be capable of providing an air change rate averaged over any 24 hour period of not less than 0.3 ACH. This value is approximately equal to the rate called for in the CSA Preliminary Standard F326.1 and the rate which would be achieved using ASHRAE Standard 62-1989, *Ventilation for Acceptable Indoor Air Quality,* which relates the ventilation rate to the number of occupants in the dwelling.

2.2 Research Organizations

Research organizations are also addressing ventilation issues. The Canada Mortgage and Housing Corporation (CMHC) and Energy, Mines and Resources Canada (EMR) are the two groups most actively involved in projects addressing ventilation and indoor air quality issues in residential buildings.

In the past, ventilation strategies have been based largely on ASHRAE 62-81, R-2000 Ventilation Guidelines and sound field practices. As CSA regulations continue to be developed, several basic questions relevant to ventilation requirements remain unanswered. There are questions concerning the ventilation rates and the distribution necessary to achieve adequate indoor air quality control, the regulations required to prevent interference of the ventilation system with other air handling devices in the house, and the proper operation and maintenance procedures needed to ensure that the system will remain functional.

CMHC has recognized that answers to such questions can be made complex but that the industry requires simplified solutions which are both practical and inexpensive to use in the field. As a result, work has commenced which will develop and demonstrate simplified techniques and equipment meeting the intent of the CSA F326 ventilation requirements. EMR's projects involve the computerized monitoring of several R-2000 houses across Canada. This work includes a detailed study of ventilation and indoor air quality.

Both groups continue to sponsor indoor air quality projects. CMHC is directing work to determine indoor air quality in northern housing. EMR completed a Cross Canada Air Quality Survey in 1989 which carried out air depressurization, formaldehyde, relative humidity, and passive air change tests in conventionally built new homes across the country.

In Alberta, the Innovative Housing Grants Program of Alberta Municipal Affairs has looked at the performance of different ventilation strategies for new conventional housing and, in

addition to this project on HRV performance in Alberta, sponsored a dynamic wall demonstration project to verify a new ventilation concept. Ongoing research on mechanical ventilation being conducted by the University of Alberta at the Alberta Home Heating Facility is addressing many of the questions related to the effect of the ventilation system on the overall ventilation dynamics of the house and its interaction with other active and passive ventilation sources in the house.

2.3 Manufacturers and Distributors

With preliminary standards in place, the industry now has the opportunity to work with the requirements and apply them in the field.

The predominant types of HRVs installed in Alberta are the Lifebreath units, manufactured by Nutech, and the vanEE units, manufactured by CES. Other manufacturers marketing HRVs in the province include Enviro Air, Air Changer, Venmar and Star. Most of the equipment available utilizes a crossflow core design and, due to Alberta's cold winters and the predominant use of natural gas, includes a cycling defrost mechanism, instead of a resistance preheat element, to prevent core icing during the winter months. Heat recovery ventilators have typically been installed in homes between 1800 ft^2 (167 m^2) and 2500 ft^2 (232 m^2) which require larger flow capacity models. Smaller capacity units are being used successfully in some smaller, multifamily, and retirement style homes.

Although HRVs have been available for about ten years, it was not until the R-2000 Program that builders and tradespeople became actively aware of this ventilation technology. As a result, it is difficult to estimate the number of heat recovery ventilation systems which have been installed throughout Alberta. We do know, however, that HRVs were installed in the 160 R-2000 homes registered prior to March 31, 1989 and it is believed that there may be up to ten times as many "copy-cat" R-2000 homes constructed throughout the province in which many more HRVs would have been installed. After speaking with the major HRV distributors in the province, it was estimated that between 400 and 600 units were sold in the province in 1989. The manufacturers expect this number to increase with between 5% and 10% of new homes built in Alberta in 1990 receiving heat recovery ventilation systems.

As the market for HRVs increases, it becomes increasingly important to ensure that these units are capable of providing reliable, efficient and effective ventilation. The manufacturers are responding to this need by addressing

the technical problems and concerns arising from the field use of HRV technology. Each year new models are introduced which operate more quietly, more efficiently and are more suitable for areas of Canada which experience severe winter conditions. Two companies, Conservation Energy Systems (CES) and Nutech Energy Systems (Nutech) have agreed to participate in this project in order to assist in finding effective and cost effective solutions to common problems which continue to occur in Alberta residences.

3.0 FIELD SURVEY OF EXISTING PROBLEMS

3.1 Ventilation Regulations in Alberta

The 1985 Alberta Building Code (ABC) has a number of articles which address mechanical ventilation requirements in housing. The following articles are of particular importance to this study.

Article 9.33.3.1. Dwelling units shall have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season, based on the interior finished volume of the dwelling unit. The system shall be controlled either manually by a switch or automatically.

Article 9.33.3.3. Mechanical ventilation systems for dwelling units shall include provision for introduction of fresh make-up air from the exterior.

Article 9.33.3.4. Mechanical ventilation systems in combination with central heating or cooling systems shall conform to Part 6.

Article 6.2.3.12.(1) A sufficient quantity of make-up air shall be provided for a ventilation system which exhausts air to the outdoors so as not to affect adversely appliances in the building or the exhaust system.

Article 6.2.3.12.(7) During winter operation make-up air that is introduced into the building shall be preheated.

Specific procedures for determining makeup air requirements and for measuring pressure differences in R-2000 homes are provided in the *R-2000 Home Program Design and Installation Guidelines for Ventilation Systems, January 1989*. These guidelines make allowances for infiltration occurring across the building envelope when determining makeup air requirements. In addition, discussions with the municipal and provincial regulatory authorities have indicated that, when an HRV is installed in a house and is capable of meeting the ventilation requirements of the code, a makeup air duct is required only if there are devices in the house that are capable of exhausting large quantities of air such as a range-top exhaust fan, a kitchen fan exhausting to the outside or an exhaust fan for a sauna. When an HRV is installed, a makeup air line is not required for appliances such as a clothes dryer or power vacuum which exhaust smaller amounts of air on an intermittent basis.

The issue of providing combustion air, which is related to ventilation air requirements, is addressed in STANDATA 85-DI-017R2, *Combustion Air for Dwelling Units*, issued by Alberta Labour, Building Standards Branch (Appendix A).

This directive states that combustion air cannot be provided through the make-up air duct that leads to the return air system of a furnace. Combustion air must be provided separately to the room in which the furnace and hot water heater are located.

3.2 Ventilation System Design in Alberta

In Alberta, where most houses are heated with natural gas, ventilation requirements are usually achieved by exhausting stale air directly to the outside using bathroom and kitchen fans and providing fresh air through a properly sized makeup air duct attached directly to the furnace return air plenum. When this method is used, furnace sizing should be checked to ensure that it can handle this additional load. The advantage of this method is that the fresh air is tempered before it reaches the living areas and, when the furnace fan is operating, is delivered to all parts of the house served by the heating ducts. The disadvantage, however, is that this air can cool the furnace heat exchanger to the point where condensation may occur within the furnace. In order to avoid rapid corrosion, the furnace should be designed with adequate corrosion resistance or the fresh air should be mixed with adequate return air and/or be tempered before coming in contact with the furnace heat exchanger. The heating industry recommends that the temperature of the return air over the furnace heat exchanger should not be less than $12^{0}C$.

The conventional ventilation strategy described above is not required by code to run continuously. System operation is left up to the homeowner. The designer, however, must ensure that the heated makeup air system will be operational whenever the exhaust system is running.

In addition to furnace sizing and heat exchanger concerns, if the furnace fan is operated continuously to distribute fresh air and/or reduce temperature stratification throughout the house, comfort problems can arise due to the cold outside air entering through the makeup air line and mixing with the return air. As a result, it is recommended by the heating industry in the CSA Preliminary Standard F326.1 that "supply air temperatures (in winter) to the dwelling should not be less than $17^{0}C$ with floor diffusers and not less than $13^{0}C$ with high side-wall or ceiling diffusers."
Ventilation systems designed to incorporate an HRV eliminate the problems associated with operating the conventional system and ensure good indoor air quality in a home built to R-2000 standards.

3.3 Builder and Installer Comments

Builders and mechanical installers across Alberta have had experience installing ventilation systems incorporating HRVs for approximately ten years. In this time, they have dealt with a variety of equipment types and models. Their feedback, along with findings from various research groups, has guided the manufacturers in modifying their equipment.

The builders and installers interviewed commented consistently that, although HRVs had been on the market for several years and heat recovery ventilation systems are being installed in many new homes in Alberta, they didn't feel that they were experienced with these systems. This was due to a number of reasons.

a) With a large number of installers active in the province, a trade may install only one unit a year.
b) A few companies have specialized in installing ventilation systems and do the majority of the work.
c) The equipment has changed several times over the years and few installers have had adequate exposure to the different systems to become proficient at their installation and operation.

These comments are supported by R-2000 house inspections carried out by Howell Mayhew Engineering, Inc. (HME). The final inspection of one R-2000 house in Edmonton, for example, revealed a number of installation problems that are seen in the field. (Note that this particular installation is not typical of HRV installations but was used to show what can happen when unqualified tradespeople are involved.)

The mechanical company involved was a two-man operation which takes on temporary employees to assist with heavier workloads. The principal employees had never attended an HRAI sponsored HRV training seminar and, in this case, the temporary help had neither HRAI training nor related experience. This company would expect to install two to four heat recovery ventilator systems each year.

The final R-2000 inspection was undertaken seven months after the house was initially occupied. Of primary interest during a final inspection is the installation and balancing of the HRV. Upon entering the home, there was evidence of lingering cooking odors which persisted throughout the two hour site visit. Inspection of the ventilation system indicated several areas of concern.

a) Three of the four duct lines attached to the ventilation unit were routed incorrectly. The flow of stale and fresh air was completely misdirected and, as a result, the home was not being ventilated.

b) The fresh air supply line was inoperative and, in any case, was not terminated in the proximity of an effective return air pickup. This poor duct layout was compounded by the fact that the furnace was not operating on a continuous low speed, although it had this capability.

c) The house was zoned to use two separate furnaces, one for the main floor and one for the second floor. Each furnace had separate return air ducting so that fresh air could only be supplied to the main floor.

d) The system was not equipped with flow measuring stations or dampers which are necessary to balance the HRV. Considering the system's mode of operation and lack of balancing equipment, it was fair to assume that the system had not been balanced.

e) Sound isolation dampers were not installed in the duct work so that the system was noisier than necessary.

f) The dehumidistat control was not installed.

Since the homeowners had not received any verbal or written instruction on the operation of the ventilation system, they were not aware that the HRV was not functioning as designed and that fresh air was not being provided to the home. Had this not been an R-2000 house, an inspection would not have been carried out and the problems would not have been discovered.

The builder and installer comments, and the inspections carried out by HME, suggest that the typical mechanical tradesperson is not adequately trained to properly install and commission ventilation systems. Indications are that this situation will not change until the demand for these systems increases substantially. In February 1990, HRAI offered a design and installation course in Edmonton intended to certify contractors to install residential mechanical ventilation systems. The course had to be cancelled due to lack of interest. In Calgary, about 15 people attended the course.

3.4 Homeowner Comments

To investigate ventilation system problems occurring in the field, 20 homeowners throughout Alberta and an additional ten homeowners in the Edmonton area were interviewed

regarding the operation and performance of their ventilation system. Twenty-three of these homeowners lived in registered R-2000 homes while the remaining seven occupied energy efficient homes not built under the R-2000 Program. Only homeowners whose homes were equipped with CES or Nutech equipment were interviewed, in accordance with these companies' agreement to participate in this study.

Prior to telephone interviews with the 20 homeowners outside Edmonton, each participant was sent a ventilation system inspection checklist to complete. In this way, the homeowners had the opportunity to familiarize themselves with the system and identify problems that were occurring prior to the interview. Separate checklists were prepared for owners of Lifebreath and vanEE units and have been included in Appendix B and C.

The results of the interviews are presented in Table 1 in a *Problems - Cause - Solution* format and represent actual homeowner responses.

Table 1a: RESULTS OF FIELD SURVEY (Based directly on homeowner responses)

Category	Problem	# of Times	Cause	# of Times	Solution	# of Times
HRV components	Damper motor failed	10	Not known	11	Component replaced	11
	Fan motor failed	1				
	Filter shrunk when washed	5	Poor quality filter	5	Replaced with different filter	3
					Not resolved	2
	Clips on door poor	3	Bend, rings fall off	3	Not resolved	3
	Condensate leaking down side of hose	1	Drip pan connection leaking	1	Sealed with silicone	1
	HRV cabinet filled with water	3	Drip pans positioned incorrectly	1	Pans repositioned	1
			Core(s) positioned incorrectly	2	Core(s) repositioned	2
Design and Installation	Outside hoods not accessible	2	Deck built over them	2	Not resolved	2
	HRV sized too small	1	Poor duct layout	1	Not resolved	1
	Ductwork not installed properly	3	Lack of trained personnel	7	Contractor recalled	7
	Dryer hood used for HRV intake	1				
	Supply, not exhaust, in kitchen	1				
	Dehumidistat not installed	2				
Commissioning and Servicing	Did not work well when first installed	1	Lack of trained personnel	5	Contractor recalled	3
	Flow measuring stations not installed	2				
	System not balanced	1			Not resolved	1
	Service personnel not available	1			Not resolved	1
Maintenance	Screen greater than 50% blocked	12	Do not clean often enough	4	Check frequently - every 2 months	11
			Never thought of it	7		
			Under deck, poor access	1	Not resolved	1
	Dirty filters	5	Do not clean often enough	5	Clean/wash 3 - 4 times per year	5
	Motors never oiled or oiled once	13	Did not know it had to be done	6	Oiled once aware of requirement	4
					Not resolved	2
			Too difficult to carry out	7	Not resolved	7
	Dirty exhaust registers	2	Have never been cleaned	2	Will check when HRV cleaned	2
	Sharp edges on core when replacing	1	Manufacturing process	1	Not resolved	1
	Little to no maintenance carried out	5	No manual or instructions	5	Not resolved	5

Table 1b: RESULTS OF FIELD SURVEY (Based directly on homeowner responses)

Category	Problem	# of Times	Cause	# of Times	Solution	# of Times
Noise/Vibration	Vibration to floor above	2	Blower wheel unbalanced	1	Blower wheels replaced	1
			Not known	1	Not resolved	1
	Variable speed control noisy	2	Not known	2	Replaced with hi/lo/off switch	1
	Whole system noisy	1	Has not looked at unit closely	1	Not resolved	2
	Furnace noise	2	Continuous low speed too fast	2	Not resolved	2
Condensation and Icing	Frost on duct lines	6	Not known	5	Not resolved	6
			Not insulated	1		
	Frozen core	8	Defrost motor not operating	4	Defrost motor replaced	1
			Defrost cycle too short	3	Defrost time lengthened	3
			Not known	1	Unit shut down until thawed	1
	Frost blocking intake screen	2	Not known	2	Frost knocked off	2
Air Quality	Dryness (no central humidifier)	5	Too much ventilation	5	Not resolved	5
	Lingering odors	3	Inadequate flow on high speed	3	Not resolved	3
Homeowner	Senior not able to service	1	Does not feel capable	1	Not resolved	1
	Drafty	3	Cold air through ducts	2	Not resolved	2
			Dumps cold air into basement	1	System not used	1
	Does not know how it works	1	Not instructed on use	1	Not Resolved	1
Other	No manual	8	Never received or misplaced	8	Not resolved	7
					Requested from builder	1
	Remote timer switch stuck on high	1	Faulty timer	1	Repaired	1
	Remote switches left on	1	Children	1	Disconnected	1

4.0 FIELD INVESTIGATION

4.1 Houses Investigated

Ten houses in the Edmonton area were chosen for the field investigations - five with Lifebreath units and five with vanEE units. The information gathered during the field survey, combined with HME's experience with R-2000 house inspections, indicated that ventilation system problems can occur even when a house is constructed by a conscientious and experienced builder of R-2000 homes using an experienced HRV installer. For this reason, the sample of Edmonton houses included builders and mechanical trades with varying levels of expertise. Basic information on the mechanical systems is presented in Table 2.

In addition to these ten houses, the computerized monitoring results of two R-2000 houses in another HME project were studied to detect any additional HRV problems. The warm weather data from these houses revealed that the total defrost time averaged approximately one hour each day with the Lifebreath unit while there was no defrost cycling in the vanEE unit. The difference was traced to the occurrence of defrost cycling in the Lifebreath unit at temperatures well above those specified by the manufacturer. These results are discussed in detail in Section 5.4.

4.2 Initial Site Visit

During the initial site visit, the mechanical system was inspected to determine how it was operated and maintained by the homeowners. The inspection was carried out with the homeowners present to provide them with a better understanding of their system and to assist them in identifying problems during the ensuing winter months. Observations made during the initial visit are presented in Table 2.

The following inspection tasks and measurements were carried out during the initial visit.

1. <u>Inspect Weatherhoods and Verify Flows</u>

The weatherhoods were inspected for proper location, height above ground and blockage of the screens.

* The hoods were properly located and were installed at the proper height above grade in all of the homes.

* The screens of four of eight homes inspected had blockage greater than 50% with one of these screens being completely covered over with debris.

* Home-LB3 had a deck which made the intake weatherhood completely inaccessible. The homeowner, who built the deck, has agree to provide access to it in the spring.

* The deck of Home-VE1 provided only 18 inches (457 mm) clearance so that the hoods could only be inspected by "snaking" one's way under the deck. The intake hood of this home was almost completely blocked.

* The weatherhoods of Home-LB5 were a snorkel-type that did not have screens.

Once the screens had been cleaned, flows through the intake and exhaust hoods were checked to verify that both HRV motors were operating and that ducting had been properly connected.

2. Inspect Ventilation System

Inside the house, the ventilation system was checked to ensure that all system controls and HRV components were functioning properly. This included a check of the remote switches, the dehumidistat, the variable speed control and the defrost cycle.

* The dehumidistat had not been installed in House-VE3 and House-VE5.

* The defrost damper motor was not operating in House-LB4.

* In House-LB4, one of the HRV cores was inserted backwards, the other was upside-down.

* Flow measuring stations had not been installed in House-LB2.

* Ducting was concealed behind a drywalled basement ceiling in House-LB5 and House-VE1.

* Duct joints were sealed only in House-LB3.

3. Measure HRV, Makeup and Combustion Flows

Once this task was completed, the supply air entering (SAE) and the exhaust air leaving (XAL) the HRV were measured using the installed flow measuring stations (FMS) and then verified using a hot wire anemometer (HWA). Next, the HRV filters and cores were inspected and cleaned as necessary and the flows remeasured. Then, any exposed duct joints were taped and the flows remeasured. Finally, flow rates through the makeup and combustion air ducts were measured using the HWA.

* Although some of the filters and cores required cleaning, none of the measured flows were significantly affected.

* In all of the houses, very few duct joints were exposed because the cold side ducting is covered with insulation and a vapour barrier, and most of the warm side ducting is concealed within the walls of the house. As a result, the small amount of taping that was carried out did not significantly affect flows.

The measured flow data is presented in Table 3. The *Total Measured Flow*, which includes the supply air entering and the continuous flow of makeup and combustion air, was compared to the flowrates recommended in the CSA F326.1 standard.

4.3 Cold Weather Site Visit

When the outdoor temperature dropped below $-25^{0}C$, each of the homes was visited again to observe HRV operation during cold winter conditions. Changes were made to each ventilation system as required to ensure that the systems would provide good indoor air quality during severe winter conditions. Conditions noted during this time, such as frost on intake screens, and the changes made to the different systems are presented in Table 2.

Table 2a. **RESULTS OF FIELD INVESTIGATION (Lifebreath Units - LB)**

House	Mechanical System	Comments	System Changes Carried Out During Investigation
LB-1	Lifebreath 195/DCS (Manufactured Dec. 1987) Medium efficiency furnace Direct vent water heater	- frost build up has occurred on intake screen - icing occurs on outside air intake duct - duct joints not sealed - defrost damper motor replaced once - core freeze-up occurred in previous heating season before defrost time lengthened - HME witnessed defrost cycling at +5°C - no makeup air duct installed - combustion air terminates in bucket at floor - noise complaints because continuous low furnace speed too fast	- existing outdoor air intake duct replaced with one piece insulated flexible duct system - defrost time adjusted to maximum - condensate leakage from drip pan repaired - flows adjusted to meet CSA F326.1 requirements - circuit board replaced - motor and temperature sensor upgraded
LB-2	Lifebreath 300/DCS (Manufactured Mar. 1988) Medium efficiency furnace Direct vent water heater	- frost build up has occurred on intake screen - icing does not occur on outside air intake duct - flexible duct installed on intake - duct joints not sealed - defrost damper motor replaced 4 times - core freeze-up occurred in previous heating season before defrost time lengthened - HME witnessed defrost cycling at +5°C - flow measuring stations not installed - homeowner did not know HRV had dehumidistat - makeup air duct installed - combustion air terminates in bucket at floor	- defrost motor replaced once - flow measuring stations installed - flows adjusted to meet CSA requirements - makeup air line blocked off - flows adjusted to meet CSA F326.1 requirements - circuit board replaced - motor and temperature sensor upgraded
LB-3	Lifebreath 300/DCS (Manufactured Aug. 1988) Medium efficiency furnace Direct vent water heater	- HRV hoods under deck and cannot be inspected - condensation and icing on outdoor air intake duct has not occurred - duct joints taped - core freeze-up occurred during investigation - makeup air duct installed - JenAir kitchen range installed - combustion air terminates in bucket mounted on furnace just above combustion chamber	- homeowner blocked off makeup air line understanding potential problems when operating JenAir - defrost time adjusted to maximum - flows adjusted to meet CSA F326.1 requirements - circuit board replaced - motor and temperature sensor upgraded
LB-4	Lifebreath 300/DCS (Manufactured Mar. 1988) 2 medium efficiency furnaces Direct vent water heater	- icing occurs on outside air intake duct - duct joints not sealed - defrost damper motor replaced during study - cabinet of HRV was filling with water because one core was upside-down, the other backwards - remote dehumidistat installed in addition to the one on the HRV - makeup air duct installed - JenAir kitchen range installed - combustion air terminates in bucket at floor	- defrost damper motor replaced - defrost time adjusted to maximum - cores installed correctly - existing outdoor air intake duct replaced with one piece insulated flexible duct system - flows adjusted to meet CSA F326.1 requirements - circuit board replaced - motor and temperature sensor upgraded
LB-5	Lifebreath 300/DCS (Manufactured Aug. 1987) Medium efficiency furnace Direct vent water heater	- snorkel-type weatherhoods without screens - outside air intake duct concealed behind drywalled basement ceiling - visible duct joints not sealed - defrost damper motor replaced twice - no makeup air duct installed - combustion air terminates in bucket at floor	- defrost damper motor replaced - defrost time adjusted to maximum - flows adjusted to meet CSA F326.1 requirements - circuit board replaced - motor and temperature sensor upgraded

Table 2b. **RESULTS OF FIELD INVESTIGATION (vanEE Units - VE)**

House	Mechanical System	Comments	System Changes Carried Out During Investigation
VE-1	vanEE 2000.2D (Manufactured Nov. 1986) Boiler and radiant system Separate ducting for HRV	- HRV hoods under deck and cannot be inspected - all ducts concealed behind drywalled basement ceiling - fresh air ducting throughout house - radiant infloor heating system - no makeup air line installed - mechanical room not part of house so combustion air duct not a concern	- no changes carried out
VE-2	vanEE 2000.2DSL (Manufactured Nov. 1987) High efficiency furnace Direct vent water heater	- defrost damper motor replaced once - icing occurs on outside air intake duct - duct joints not sealed - system run only intermittently because of drafts, vibration and noise - makeup air duct installed - combustion air duct not required	- existing outdoor air intake duct replaced with one piece insulated flexible duct system - damper installed to control makeup flow - flows adjusted to meet CSA F326.1 requirements
VE-3	vanEE 2000/SLD (Manufactured Dec. 1987) Medium efficiency furnace Direct vent water heater	- frost build up has occurred on intake screen - icing occurs on outside air intake duct - duct joints not sealed - the dehumidistat was not installed - makeup air duct installed - combustion air is provided through a short duct attached to the supply air furnace plenum	- existing outdoor air intake duct replaced with one piece insulated flexible duct system - converted makeup air line to combustion air line that meets current requirements - flows adjusted to meet CSA F326.1 requirements
VE-4	vanEE 2000/VLD (Manufactured Jan. 1989) Medium efficiency furnace Direct vent water heater	- icing occurs on outside air intake duct - duct joints not sealed - makeup air duct not installed - combustion air terminates in bucket at floor	- existing outdoor air intake duct replaced with one piece insulated flexible duct system
VE-5	vanEE 2000/VLD (Manufactured Feb. 1989) 2 medium efficiency furnaces Direct vent water heater	- HRV too small to meet ventilation requirements - flexible duct installed on intake - duct joints not sealed - the dehumidistat was not installed - two makeup air ducts - combustion air terminates in bucket at floor	- no changes until decision made on whether or not HRV will be replaced

Table 3. INITIAL FLOW MEASUREMENTS

House Identification Number			LB-1		LB-2		LB-3		LB-4		LB-5		VE-1		VE-2		VE-3		VE-4		VE-5	
Recommended Flowrate																						
Based on Total Volume, 0.3 ACH (L/s)			55		58		106		95		*[1]		*		66		42		59		*	
Based on CSA F326 Room-by-Room (L/s)			70		70		85		95		75		65		70		55		60		80	
Measured Flowrates			FMS[2]	HWA[3]	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA
a) HRV	Continuous	SAE[4] (L/s)	108	113	*	*	81	67	64	78	*	74	35	*	59	64	51	62	66	74	34	37
		XAL[5] (L/s)	89	89	*	*	76	80	59	68	*	75	57	*	62	58	54	56	72	74	34	32
	Balancing: (SAE-XAL)/SAE		18%	21%	*	*	6%	-19%	8%	13%	*	-1%	-63%	*	-5%	9%	-6%	10%	-9%	0%	0%	14%
	High speed	SAE (L/s)	124	*	*	*	97	*	74	*	*	*	72	*	73	*	73	*	*	*	60	*
		XAL (L/s)	109	*	*	*	87	*	68	*	*	*	85	*	79	*	79	*	*	*	73	*
	Balancing: (SAE-XAL)/SAE		12%	*	*	*	10%	*	8%	*	*	*	-18%	*	-8%	*	-8%	*	*	*	18%	*
b) Makeup Air	Furnace fan low (L/s)		Not Installed		30		24		28		Not Installed		Mechanical Room in Garage		25		28		Not Installed		32	
	Furnace fan high (L/s)				42		24		28						44		32				43	
c) Combustion Air	Furnace off (L/s)		12		10		9		9		10				Not Required		Included in Makeup		10		9	
Total Measured Flowrate (HWA + Makeup + Combustion)		(L/s)	125		*		100		115		84		35		89		90		84		78	
Difference From CSA Recommended			79%		*		18%		21%		12%		-46%		27%		64%		40%		-3%	

1. * denotes data not available
2. Designates measurement using flow measuring station
3. Designates measurement using hot wire anemometer
4. Designates supply air entering
5. Designates exhaust air leaving

4.4 Discussion of Initial Flow Measurements

1. Balanced Flows

The supply and exhaust flow rates were measured with both the flow measuring stations (FMS) and with a hot wire anemometer (HWA) in order to verify the accuracy of the FMS. Since the manufacturer states that the accuracy of these devices is approximately ±8%, it is imperative that the FMS are installed and balanced exactly as specified by the manufacturer. The manufacturer's information on positioning the FMS and on the balancing procedure is included in Appendix F. Measurements indicated that three houses which appeared to have continuous flows balanced to within 10% of the supply air flow based on FMS readings were not balanced when checked with the HWA. In each of these houses, the FMS were not installed according to the manufacturer's instructions.

2. Ventilation Flowrates

The *Total Measured Flow* presented in Table 3 represents the sum of the supply air entering the house through the HRV and the continuous flow of outdoor air entering the house through the makeup and combustion air ducts. These flows varied from 46% lower to 79% higher than those recommended by CSA F326. Note that the makeup air flow included in the *Total Measured Flow* was the value measured with the furnace on a low continuous speed. When the furnace was firing and the fan was on high speed, four of the houses recorded higher makeup air flows.

Two of the houses had flowrates lower than CSA recommended rate. House-VE1 was heated with a radiant system and had a ducting system installed on the supply side. Initial measurements indicated significantly reduced flows on the supply side. House-VE5 had an HRV that was sized too small for the ducting system that was installed. The builder and ventilation contractor are working to resolve this problem.

4.5 Final Site Visit

The purpose of this visit was to inspect the system after a heating season of operation to detect any additional problems and to ensure that the system was functioning effectively. During the visit, the ventilation system was inspected and components were replaced as necessary. If cleaning was necessary, the homeowner was informed and encouraged to carry out the necessary maintenance. Air flows were adjusted and balanced to the required amount of ventilation air using the flow measuring stations. In

addition, flow rates were measured using the hot wire anemometer. Finally, the role and need for the makeup air line was discussed with each homeowner.

Comments on each site visit are given below and the results of the flow measurements are presented in Table 4.

Site Visit Comments

LB1 * The defrost circuit board was replaced to eliminate the defrost cycling occurring at temperatures above freezing.
* The temperature sensor and damper motor were upgraded with improved components provided by the manufacturer.
* The HRV airflows were adjusted and balanced.
* This house does not have a makeup air duct.

LB2 * The defrost circuit board was replaced to eliminate the defrost cycling occurring at temperatures above freezing.
* Flow measuring stations were installed. The ventilation contractor had not installed them initially. Dampers in the fresh and exhaust air lines are still not installed.
* The HRV airflows were adjusted but could not be balanced because dampers had not been installed. The homeowner will have the ventilation contractor return to install dampers and balance the system.
* Based on information from the *R-2000 Home Program Design and Installation Guidelines for Ventilation Systems, January 1989*, and HME discussions with municipal and provincial regulatory authorities, the homeowner has blocked off the makeup air duct.

LB3 * The defrost circuit board was replaced to eliminate the defrost cycling occurring at temperatures above freezing.
* The temperature sensor and damper motor were upgraded with improved components provided by the manufacturer.
* The HRV airflows were adjusted and balanced.
* Based on information from the *R-2000 Home Program Design and Installation Guidelines for Ventilation Systems, January 1989*, and HME discussions with municipal and provincial regulatory authorities, the homeowner has blocked off the makeup air duct.

LB4 * The defrost circuit board was replaced to eliminate the defrost cycling occurring at temperatures above freezing.
* The HRV supply air filter was heavily matted with debris and had to be cleaned.
* The HRV airflows were adjusted and balanced.

* The makeup air line in this house was not altered because the home has a large exhausting kitchen appliance.

LB5
* The defrost circuit board was replaced to eliminate the defrost cycling occurring at temperatures above freezing.
* Based on the hot wire anemometer (HWA) readings, the supply air flow measuring station did not appear to be functioning properly.
* The HRV airflows were adjusted and balanced based on the HWA readings.
* No makeup air line was installed in this house.

VE1
* It was not possible to arrange a final visit with this homeowner before the project was completed.
* No makeup air line is installed in this house.

VE2
* The HRV airflows were adjusted and balanced.
* The manufacturer is supplying the homeowner with a new core to replace the current one which has damaged core guides and replacement blower wheels to eliminate a vibration problem.
* Based on information from the *R-2000 Home Program Design and Installation Guidelines for Ventilation Systems, January 1989*, and HME discussions with municipal and provincial regulatory authorities, the homeowner was advised to block off the makeup air duct.

VE3
* The homeowner was advised to clean the core, filters and intake weatherhood screen. These were very dirty due to house construction next door.
* The airflows were adjusted and balanced.
* Based on the *R-2000 Home Program Design and Installation Guidelines for Ventilation Systems, January 1989*, and discussions with municipal and provincial regulatory authorities, the homeowner was advised to have a heating contractor convert the combination makeup/combustion air ducting arrangement to a combustion air line only, thereby eliminating the makeup air line.

VE4
* The homeowner was advised to clean the core, filters and intake weatherhood screen. These were very dirty due to house construction next door.
* The airflows were adjusted and balanced.
* No makeup air line was installed in this house.

VE5
* The final visit to this house was dependent upon the builder and/or heating contractor returning to make modifications to the system. These changes have not been carried out and a final visit was not made.

Table 4. FINAL FLOW MEASUREMENTS

House Identification Number	LB-1		LB-2		LB-3		LB-4		LB-5		VE-1		VE-2		VE-3		VE-4		VE-5	
Recommended Flowrate																				
Based on Total Volume, 0.3 ACH (L/s)	55		58		106		95		*[1]		*		66		42		59		*	
Based on CSA F326 Room-by-Room (L/s)	70		70		85		95		75		65		70		55		60		80	
Measured Flowrates	FMS[2]	HWA[3]	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA	FMS	HWA
a) HRV Continuous SAE[4] (L/s)	66	68	72	87	85	85	56	66	67	76	*	*	59	64	47	50	54	66	*	*
XAL[5] (L/s)	66	74	68	77	85	90	53	60	78	80	*	*	62	58	50	59	58	74	*	*
Balancing: (SAE-XAL)/SAE	0%	-9%	6%	11%	0%	-6%	5%	9%	-16%	-5%	*	*	-5%	9%	-6%	-18%	-7%	-12%	*	*
High speed SAE (L/s)	79	*	87	*	88	*	63	*	69	*	*	*	73	*	60	*	65	*	*	*
XAL (L/s)	75	*	78	*	87	*	71	*	85	*	*	*	79	*	62	*	70	*	*	*
Balancing: (SAE-XAL)/SAE	5%	*	10%	*	1%	*	-13%	*	-23%	*	*	*	-8%	*	-3%	*	-8%	*	*	*
b) Makeup Air Furnace fan low (L/s)	Not Installed		Blocked		Blocked		28		Not Installed		Mechanical Room in Garage		Blocked		Removed		Not Installed		*	
Furnace fan high (L/s)							28												*	
c) Combustion Air Furnace off (L/s)	12		10		9		9		10				Not Required		12		10		*	
Total Measured Flowrate (L/s) (HWA + Makeup + Combustion)	80		97		94		103		86		*		64		62		76		*	
Difference From CSA Recommended	14%		39%		11%		8%		15%		*		-9%		13%		27%		*	

1. * denotes data not available
2. Designates measurement using flow measuring station
3. Designates measurement using hot wire anemometer
4. Designates supply air entering
5. Designates exhaust air leaving

4.6 Discussion of Final Flow Measurements

1. Balanced Flows

The supply and exhaust flow rates were once again measured using a micromanometer and the flow measuring stations (FMS) and verified with a hot wire anemometer (HWA).

* Three houses, LB2, VE3 and VE4, which appeared to have continuous flows balanced to within 10% of the supply air flow based on FMS readings were not balanced when checked with the HWA. Proper positioning of the FMS would likely correct these differences.
* Only one house, LB4, could not be balanced so that it remained in balance when switched to high speed. LB5 was balanced using the HWA reading and was not checked on high speed.

2. Makeup Air Flows

The makeup air remained in only one house. Eliminating the air flow through this line reduced the *Total Measured Flow* and will result in reduced heating bills, higher indoor relative humidity levels and more comfortable continuous airflows during cold winter months.

3. Ventilation Flowrates

The *Total Measured Flow* presented in Table 4 represents the sum of the supply air entering the house through the HRV and the continuous flow of outdoor air entering the house through the makeup and combustion air ducts. The total flow varied from 9% lower to 39% higher the flow recommended by CSA F326. With most of the makeup airflows eliminated, these higher flows are now due mainly to the continuous flow of air through the combustion air line.

Two of the houses had flowrates lower than recommended by CSA F326. House-LB3 had a very large volume compared to the number of rooms and required a higher continuous flow rate. House-VE2 is operated at a lower ventilation rate because of homeowner preference.

5.0 PROBLEMS AREAS AND RECOMMENDED SOLUTIONS

From the field survey of regulatory agencies, researchers, manufacturers, distributors, builders, installers and homeowners, specific problem areas emerged which became the focus of the field investigation. These problem areas, along with proposed solutions, are detailed below. Included with a number of the problem areas, are excerpts from the CSA Preliminary Standard F326.2, *Residential Mechanical Ventilation System Installation Requirements* (published in December 1989) that pertain to that specific area.

5.1 Education and Training

The industry recognizes that achieving proper ventilation will require expert designers and installers as well as knowledgeable inspection authorities. The task of education and training is currently being handled by the Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) and the manufacturers.

* HRAI has developed a course to enable industry members to understand the principles of good ventilation design and installation and the requirements of the F326 standards. Each year, this course is presented in selected centers across Canada.

* In Alberta, the Lifebreath manufacturer prefers to deal directly with only licensed, and if possible, bonded heating and ventilation contractors. Nutech notifies these contractors when HRAI training seminars are being presented in their area and encourages them to attend. In areas where sales are high, Nutech employs a sales representative to respond to the needs of both installers and homeowners. Nutech also maintains a full training facility at their head office in London, Ontario.

* The vanEE manufacturer deals through local distributors, such as Sinclair Supplies in Edmonton and Calgary. They maintain an education and training center at their head office in Saskatoon where they provide courses for personnel promoting and installing their ventilation systems. They presented about ten of these courses over the past winter. In addition, training courses are held in any region on a demand basis such as one recently held in Calgary in conjunction with SAIT, the Southern Alberta Institute of Technology. In Alberta, they also have a manufacturer's representative that will set up training sessions to address regional needs.

Despite these efforts, however, most of the ventilation system problems that occur result directly from poor or incomplete installations carried out by unqualified tradespeople or contractors that do not have a clear understanding of ventilation principles and have not kept abreast of technical advancements in this field. Since most trades in Alberta install only one or two units each year, experienced personnel are typically not available. As a result, "HRV specialists" are emerging to fill the need for trained ventilation system personnel.

* A number of experienced R-2000 builders in Alberta have addressed the problem by becoming experts themselves. They design their own systems, supervise or carry out the installation and complete the detailed tuning of the units. These builders have often extended their personal training on HRV installation by participating as HRAI and R-2000 Workshop instructors.

* A knowledgeable consultant in Whitehorse has addressed this problem by contracting with the companies installing HRVs to carry out the "finish installation" and the commissioning of the HRV after the unit has been roughed-in and hung. During his initial visit, which coincides with the hanging of the unit, he seals all duct joints, gathers up the controls and stores them in a bag which is left inside the unit, and ensures that the system is left unplugged. In this way, he protects the controls from damage and the HRV from contamination with construction dust. Once the house construction is complete, he returns to the site and installs the rest of the system. He seals the duct vapour barrier, levels the unit, balances the flows, adjusts the defrost timing cycle, sets the controls and generally ensures that the unit is operating properly. The contractors like this arrangement because it reduces unprofitable time in the field and virtually eliminates callbacks.

Although utilizing an HRV specialist appears to be an effective way to ensure that a ventilation system will be installed correctly and provide the ventilation essential to tighter, energy efficient homes, there appears to be reluctance in Alberta to involve such a specialist. During this project, HME initiated a mailout to Edmonton builders, installers and homeowners offering ventilation system commissioning and maintenance services. Despite all of the problems that are occurring in the field, the response to this mailout was minimal.

If it is recognized and accepted that natural ventilation is not sufficient to ensure acceptable indoor air quality during the winter heating season, and if it is also recognized that proper ventilation will require expert

installers and designers as well as knowledgeable inspection authorities, then education and training must become a priority. If installers are not ready to accept the responsibility of ensuring that the ventilation systems they install can provide good indoor air quality, then steps must be taken by the industry to regulate the installation of these systems.

5.2 Homeowner Servicing and Maintenance

1. Information Guides and Labelling

The following clauses from the CSA preliminary installation standard pertain to this section.

CSA 326.2: 4.9.1.1.(d) - *Packaged ventilators shall be accompanied by up-to-date, clear, correct and comprehensive instructions, tables and graphs as supplied by the manufacturer for informing the purchaser* (homeowner) *about operations, controls, minor trouble-shooting and routine maintenance, and providing an up-to-date parts list with suppliers (this information shall be provided as a separate document to the purchaser.)*

CSA 326.2: 4.9.1.3 - *Packaged ventilators shall be accompanied with a clearly written warranty and with labels in English and French affixed to any component that requires a marking indicating that cleaning and/or maintenance is required.*

CSA 326.2:5.10 Other Factory-Assembled Ventil. Components
Other factory-assembled ventilation components that affect the ventilation flow rate, such as ventilation air inlets and exhaust air outlets, filters and screens, shall be accompanied by the following information:

(c) maintenance procedures;

CSA 326.2: 5.10 Labelling - *Appropriate labels in English and French shall be affixed to all elements of a unit which require caution or need to be identified for cleaning and/or maintenance.*
Note: *It is recommended that labels for filters include instructions regarding cleaning or replacement, or both.*

Regardless of the reliability of the unit and the quality of the installation, if the ventilation system is not maintained on a regular basis it will not remain capable of providing good indoor air quality. If the homeowner ignores simple procedures such as cleaning the exterior hood screen

on the fresh air intake and the filters inside the HRV, the unit can become incapable of providing an adequate ventilation air to the house within a few months.

Based on homeowner suggestions and discussions with the manufacturers, a number of changes can be made that will increase the likelihood of maintenance being carried out.

Maintenance and operating instructions should be visible and fixed to the unit. Homeowners in this study typically did not have the *Operating and Service Guide* available because it was either misplaced or never received. As a result, if and when the homeowner wished to carry out maintenance procedures or verify the operation of the HRV, the guide could not be located. VanEE units currently have a *Service Information* label fixed to the face of the core inside the unit. A label such as this is very useful but should also be fixed to the front of the unit.

It is recommended that an information label be affixed to both the front panel on the outside of the HRV and to the face of the core inside the unit. In this way:

a) the outside label is clearly visible to anyone viewing the unit and will serve as a reminder that maintenance is required; and

b) the inside label will serve as a service guide once the unit has been opened and assist the homeowner in determining the orientation of the core when replacing cores that have been removed for servicing. In House LB-4, where labels were not attached to the cores, one of the cores was in backwards and the other was in upside down. The homeowner had never removed either core. Since the cores had to be removed to install the drain tray, it is probable that the installer replaced the cores incorrectly. In another test home, where the homeowner carried out some maintenance on his system, the core was replaced incorrectly and the inside of unit was flooded with condensate.

   NOTE: If an information label is not affixed to the core(s), some other method is essential to ensure that, when the core(s) are removed for servicing, they can be oriented properly when they are replaced.

An alternative to an information label affixed to the outside panel would be a stick-on clear plastic envelope permanently attached to the front of the HRV that would contain the *Operating and Service Guide* and any other information the homeowner would require.

Nutech is currently investigating the use of a "peel-and-stick" information label and will make changes based on the above recommendations and CSA F326.2 requirements. CES had prepared comprehensive labels that were to be mounted on the front panel of the unit and include service and maintenance information, troubleshooting information and information on who to call if other problems arise. There has been resistance by sales representatives in the field, however, who claim that the unit does not appear as "clean" on the exterior and is not accepted as well based purely on aesthetics. CES now plans to have information with the CSA label on the front panel that will indicate that there are detailed maintenance instructions located inside the unit.

2. Exterior Intake Screen and Interior Exhaust Registers

The following clauses from the CSA installation standard pertain to this section.

CSA 326.2: 5.6.5 - *Outdoor air intakes shall be clearly labelled as such for identification from locations outside the dwelling.*

CSA 326.2: 5.6.6 - *Supply air intakes and exhaust air outlets shall be shielded to prevent entry of animals and insects. If an insect filter or screen is of a material that may be readily damaged by an animal, it shall be protected by an additional screen on the outside. Insect screens or filters shall be removable for cleaning or replacement without recourse to special tools. All screens and filters shall be of corrosion-resistant materials.*

It is recommended that requirements for labelling on outdoor intake grills be expanded to include exhaust grills and require that these hoods remain accessible for maintenance. The manufacturers' installation guide should also include this advisory so that these hoods do not become inaccessible when an addition, such as a deck, is made to the house. The hoods in two of the ten homes investigated in this study were virtually inaccessible for this reason.

It is strongly recommended that maintenance procedures be expanded to include the inspection of outside screens and interior exhaust registers. This is extremely important with regards to the screen on the exterior fresh air intake hood. The one-quarter inch (6 mm) mesh typically used in this weatherhood often becomes clogged with airborne debris. In the wintertime it can also become blocked with frost (Section 5.3(1)). Almost half of the homeowners surveyed had outdoor hood screens that were up to 90% blocked and most of them did not even realize that the screen had to be cleaned.

This blockage can result in a reduced supply of fresh air to the house, imbalanced flows causing a negative indoor pressure and the potential for backdrafting.

3. Supply and Exhaust Motors

While servicing outdoor weatherhoods, it is logical to verify the operation of supply and exhaust motors by checking the flows through the exterior hoods. This can be easily done by holding a sheet of paper in front of each hood. If the motors are working, the exhaust air will blow the paper away from the hood while the fresh air intake will draw the paper into the hood. It is recommended that this simple procedure also be included in the homeowner's service and maintenance guide.

Current service and maintenance guides provided by both manufacturers state that motors should be oiled. Although the procedure appears to be relatively easy to carry out, over 75% of the homeowners interviewed did not oil the motors on a regular basis. A number of the homeowners did not feel capable of involving themselves in "removing motors" and, therefore, never oiled them. Another group tried the procedure once and never attempted it again. The general comment was that if a maintenance procedure such as oiling the motors is important then it should be easier to carry out.

Discussions with the manufacturers revealed the following. Motors in Lifebreath units are described as "permanently oiled" which, according to the motor manufacturer, means that the motor will withstand five to seven years of constant operation without additional oiling. Since regular oiling will significantly increase the life of the motor, Nutech has added plastic spouts to the oil ports and recommends adding four to five drops of S.A.E. 20W non-detergent oil each year. To enable this procedure to be carried out with relative ease, Nutech has an accessory available called an "oil telespout" which fits on the plastic oil spout installed on the HRV motor. The cost of this accessory is $5.00. It is recommended that information about the availability of this accessory be supplied to the homeowner.

In the first vanEE models (the 200 Series), CES had many problems with motors burning out. As a result, they had the motor redesigned with a larger bearing shaft and a double capacity oil reservoir. The motor manufacturer is confident that this motor can withstand ten years of continuous operation without any problems. Since CES began using this motor in 1985, they have not had a single electrical or bearing failure reported. As a result, they decided to discontinue recommending that homeowners service the motors. About a year ago, the oil tubes were removed and a sticker

was put on the motor stating that oiling was not required. The oil holes in the motors now have a plastic plug so that, in the future, if someone feels that the motor should be removed and oiled then this can be carried out. Their service guides have recently been revised to reflect these changes.

4. Defrost Damper Motor

The operation of the defrost damper motor should also be verified. The defrost mechanism of a Lifebreath unit that utilizes a defrost damper incorporates a self test feature which is described in the homeowner's *Operating Instructions*. Each time power to the unit is interrupted, the unit initiates a defrost cycle and the defrost damper opens for the preset defrost interval (Section 5.3.3). This operation can easily be viewed through a defrost port at the bottom of the double core models.

With the vanEE units, the defrost cycle cannot be initiated by interrupting the power. Although it is possible to initiate the defrost cycle by manually advancing the timer, this is a procedure that the manufacturer recommends be carried out only by qualified service personnel. The homeowner can verify the operation of the defrost damper motor by opening the HRV when the defrost light indicates that the unit is on defrost and observing the damper opening and closing; or by ensuring that, when the HRV is plugged in, the damper motor is holding the damper tightly against the defrost port. The vanEE *Service and Operating Guide* for the homeowner does not include instructions on verifying the operation of the damper motor and it is recommended that the guide be updated to include this information.

5.3 Frost, Condensation and Icing

1. Outdoor Air Intake Weatherhood

Section 5.2(2) discussed reduced flow through the outdoor intake weatherhood due to blockage of the screen with airborne debris. Reduced flows can also be caused by frost buildup. In most weatherhoods, the screen is secured in place and if the homeowner notices a change in indoor air quality in the winter the intake screen should be checked and cleared if necessary. On the weatherhood supplied by vanEE, the screen is hinged and can be opened. There is a velcro fastener under the hood surface which will hold the screen and prevent it from frosting up. On earlier weatherhoods, this fastener was attached to the weatherhood with an adhesive which lasted a relatively short period of time and the screen mesh could no longer be held up or

secured down. CES has replaced this initial fastener with a piece of velcro looped through the screen and stapled. It has proven to be very reliable.

It is recommended that the homeowner guides provided by both manufacturers be expanded to include this information. In addition, it is recommended that, if a proper fastener can be located, the hinged screen be incorporated into all air intake weatherhoods.

2. Outdoor Air Intake Duct

The following clauses from the CSA preliminary installation standard pertain to this section.

CSA 326.2: 5.5.5 - *An outdoor air intake duct shall be insulated to prevent condensation on the outside of the duct from the point where it passes through the building envelope, to the point where the supply air is introduced into the living space or is tempered to above the dew point temperature of the room air. Such ducts shall have insulation with an RSI value conforming to applicable regulations but not less than 0.5. Joints in the ducts shall be sealed, and the insulation shall have, on its outer surface, an airtight and vapour retardant membrane.*

In most houses, the critical portion of ducting is the outdoor air intake duct from the building envelope to the HRV. In Alberta, the common practice is to use galvanized metal ducting covered with pipe sleeves consisting of fiberglass blanket insulation encapsulated in a polyethylene vapour barrier. Joints are rarely sealed.

It was soon discovered that the occurrence of condensation and icing on this duct was a common problem. It was initially believed that the temperature differential between the cold surface of the duct and the house air was the sole driving force that caused moisture to migrate through small penetrations in the air/vapour barrier. Further investigation revealed, however, that the major driving force is duct depressurization. Duct leakage through joints, seams and elbows causes a negative pressure inside the vapour barrier which actively draws moist house air through any puncture in the vapour barrier.

In colder weather, this house air condenses and freezes on the cold duct surface reducing the effectiveness of the insulation and decreasing the overall system efficiency significantly. In milder weather, the ice buildup melts and accumulates inside the vapour barrier or drips back into the house potentially causing water damage. In two of the test houses, this duct was concealed behind a drywalled ceiling in a finished basement. Water leakage back into these homes could have serious consequences.

It is recognized that it is necessary to ensure duct joints, seams and elbows, are completely sealed, well insulated and covered by a continuous air/vapour barrier. As a result, both manufacturers offer insulated flexible ducting systems (Appendix D). In addition, vanEE now has available a double insulated flexible duct which consists of a flexible duct surrounded by two layers of fiberglass wrapped alternately so that the seam of the first layer is covered by the second layer. Although a bit bulkier, this product will significantly reduce intake air preheating and improve overall system efficiency.

The installation manuals for both the Lifebreath and vanEE units state that insulated flexible ducts should be used on both the intake and exhaust connections from the HRV to the outside. It is strongly recommended, however, that these manuals be changed to state that these products ***must*** be used and, in addition, to provide information about the serious consequences of not using them.

3. Core Freeze-Up

When core icing cannot be controlled by the HRV defrost mechanism, the core freezes and the house no longer receives adequate ventilation air. Core freeze-up can occur for a number of reasons including:

a) damper motor failure (Section 5.4(1));
b) imbalanced air flow; and
c) low defrost air temperatures. (The average temperature of the room where the unit is installed must be above 18^{0}C).

In the Lifebreath units, core freeze-up can also be caused by improper defrost duration and defrost interval settings. Up until November 1989, Lifebreath models equipped with an electronically controlled damper door defrost mechanism were factory pre-set for frost-free operation down to -25^{0}C. If the outside temperature dropped below -8^{0}C, a defrost timer was activated. After waiting approximately 30 minutes, the timer activated the damper door mechanism which closed off the fresh air supply port and opened the defrost port. After approximately $2^{1}/_{2}$ minutes, the damper door reversed direction and reopened the fresh air supply port and closed off the defrost port. This cycle repeated until the outside temperature rose above -8^{0}C. Since November 1989, all units have been factory set to operate without core freeze-up down to -40^{0}C.

In the Edmonton area, where the temperature can drop substantially below -25^{0}C, all of the Lifebreath units that HME investigated experienced core freeze-up. This problem was easily alleviated by adjusting the trim pots controlling the defrost time and/or the wait time between defrost

cycles. Nutech issued a *Customer Service Bulletin* in February 1989 which describes these adjustments. A copy of this bulletin is included in Appendix E. Note that in the most recent Lifebreath models the trim pots have been replaced with DIP switches to allow for the precise setting of defrost time and wait time.

Core freeze-up has not been a problem with the vanEE models. Units with the *FrostBuster™* defrost system operate normally until the supply air temperature drops below -5^0C. Once below this temperature, the unit will operate normally for 45 minutes, and then run in defrost for six minutes. This cycle will ensure operation even during extended periods of -35^0C.

The vanEE 2000Plus, a double core unit, is designed with an automatic two stage defrost system for cold climates. At a temperature of -5^0C, the first stage of defrost is actuated. When the temperature falls to -25^0C, the second stage of defrost is actuated. The second stage lengthens the amount of time the 2000Plus is in the defrost mode. Defrost operation is completely automatic. Older 2000Plus units were supplied with a toggle switch which was manually actuated for different temperature conditions. Automatic defrost replaced the manual system. This automatic defrost has recently become available on a single core model, the vanEE 2000 Igloo.

5.4 System Components

1. Defrost Damper Motors

Most of the builders and installers surveyed had experienced failures with the motor which opens and closes the defrost damper. This failure prevents defrosting and eventually leads to a complete freeze-up of the ventilator core. Although the damper motor may fail, the HRV fan motors are still operating and the ventilation system appears to be functioning properly. However, as ice begins to form in the core, the ventilation capacity of the HRV is reduced and air quality will deteriorate without an apparent cause.

Nutech has experienced numerous damper motor failures. Their records showed that the HRVs in which damper motors failed initially had a high percentage of repeat failures occurring shortly after the new motor was installed. They discovered that, in order to install the new motor, the installer often rotated the motor with pliers in order to align it with the door fittings. This manual rotation of the drive shaft weakened or completely stripped the internal gears in the motor resulting in a repeat failure shortly after installation. In an attempt to solve this problem,

Nutech issued a *Customer Service Bulletin* which is included with all replacement motors and provides detailed instructions on damper motor replacement. A sticker is also attached to the damper indicating that it should not be operated manually.

In addition, Nutech worked closely with the motor manufacturer to improve the reliability of the damper motor. The stall torque of the motor was found to be applying excessive pressure on the gear train when the motor was holding the damper against either the fresh air or the defrost port. In November 1989, they began using a motor in which the stall torque had been reduced by 50%. Several thousand of these motors are now in service and a failure has not yet been reported. The new motor is identified with a sticker that reads "Improved Motor".

CES has also experienced problems with the damper motor they were initially using. After investigating and analysing the reasons for these failures, CES found it necessary to insist that the manufacturer supply the most rugged motor and most durable gear train that was available. CES states that, from the same motor manufacturer, it is possible to buy motors that look identical on the outside but which are quite different on the inside. Since CES began insisting on the best possible motors the manufacturer could produce, they have had very few failures.

2. Defrost Circuit Board

As a result of testing carried out in HME's research facility, the Cold Climate Demonstration House, it was discovered that the defrost mode of a Lifebreath unit was being initiated at temperatures well above those specified by the manufacturer. The results of the computerized monitoring of a second R-2000 house supported the initial testing and showed that, for example, in the month of April, the monitored Lifebreath unit had a total defrost duration time of approximately one hour each day. Each of the five Lifebreath units in the investigative houses was also tested and all were found to experience this same problem.

It was initially believed that the problem was due to faulty temperature sensors that had been affected by condensation and corrosion. Since November 1989, Nutech has been using a hermetically sealed temperature sensor in their HRV's and, although these were installed in the problematic HRVs, they did not resolve the problem.

The only other source for the problem was the circuit board that controls the defrost cycle. This board had recently been changed to allow for the defrost time and the wait time between defrost cycles to be set easily and precisely. The new board was installed in the problematic HRVs in June 1990

and initial observations indicate that the problem is no longer occurring. Nutech remains puzzled, however, because there is no reason the initial board should not work. The questionable circuit boards are being tested at the factory and, at the time this report was published, they had not been able to duplicate the problem.

3. Defrost Dampers

The damper door in the Lifebreath units consists of a galvanized metal flap sandwiched between two layers of foam. In colder weather, as the damper door moves from one position to the other, condensation can form on the foam, accumulate on its rough surface and result in the damper freezing to the intake port. Originally, the surface of the foam was coated with a layer of silicone grease to shed this water. In January 1988, the grease was replaced with a layer of a teflon/vinyl material.

4. Door Fasteners

Both manufacturers have made changes to the fasteners that secure the hinged front panel. Homeowners often experienced that the front panel clips used on the Lifebreath unit were flimsy and came apart after repeated use. These clips have now been replaced with fasteners that are more durable. To open the front panel of the vanEE units, it was necessary to have a screwdriver available. These screws have now been changed to a winged screw that can be turned by hand.

5. Interior Filters

Initially, the filters in the vanEE units consisted of a metal frame into which a washable filter was inserted. When the filter was washed, however, it often shrank and would no longer fit in the frame. These filters have now been replaced with one piece, washable, reticulated foam filters. The Lifebreath units have aluminum filters that did not experience this problem.

6. Interior Insulation

Nutech found that, over time, some of the interior HRV insulation did not hold up as well as it could have. They are now installing a more rigid foil-backed insulation which will provide better support and seal better.

7. Front Panel Hinges

The front panel of both the Lifebreath and the vanEE are mounted on pin hinges allowing it to be removed. This is somewhat dangerous, however, since the panel may drop if bumped of its hinges. The vanEE units, with doors that doors came off very easy, are now equipped with a door stop

which allows the door to be removed but not to drop off. The front panel on the Nutech unit requires more force to be removed and is not likely to experience this problem.

8. Noise

The following clauses from the CSA preliminary installation standard pertain to this section.

CSA 326.2: 5.2 Noise & Vibration - *The installing contractor shall follow procedures outlined by the manufacturer for minimizing noise and vibration transmission, and use any materials provided for this purpose where applicable. In the absence of specific materials or instructions from the manufacturer, appropriate vibration dampening materials such as rubber grommets or flexible strips shall be used when connecting exhaust or supply fans to the building structure.*

Noise is much less of a problem now than it was when HRVs were first introduced. Units that are installed as per the manufacturer's recommendations are generally found to be quite quiet. The major difficulty in this area is ensuring that the unit is installed as per the manufacturers' instructions.

The manufacturers remain sensitive to the noise issue, however, and are constantly seeking methods of reducing noise levels. The most recent vanEE models, for example, feature the VARI-quiet™ fan speed control which eliminates the hum associated with solid state fan speed controls.

The bigger noise issue which has emerged is not directly associated with the heat recovery ventilator but results from the R-2000 requirement for a continuous supply of fresh air to each room of the house. In a house with a forced air heating system, the furnace is typically used to distribute the fresh supply air to the house and it is the noise associated with running the furnace fan continuously which results in homeowner complaints. Direct drive fan motors do not have a low enough speed setting to reduce air movement noise to acceptable levels and furnace motors which utilize a rheostat to reduce the fan speed often produce more noise on low speed than on high speed due to the rheostat control itself. Although furnace noise was not cited as a major problem by the participants in this study, it may be a problem that has to be addressed in the future if building codes change to require a continuous supply of fresh air to each room of the house.

9. Warm Side Ducting

Even if the HRV is operating perfectly, the associated ductwork can be causing problems that result in indoor air quality that is less that optimal.

An investigator/distributor/installer in British Columbia expressed the concern that the fresh air leaving the HRV was not getting to the occupied areas of the house. If the ducts on the warm side of the ventilator are simply fitted together and screwed in place, he was concerned that a large portion of the fresh air would be lost within the wall cavities before reaching the occupied spaces. This same concern was expressed with regards to the stale air exhaust line which, if unsealed, would not be drawing efficiently from the stale air sources.

He addresses this concern in his houses by ensuring that all ventilation ducting joints are at least taped. Although taping will reduce the problem, he is also concerned about tape quality and its durability. He recommends that a more permanent solution would be to use a duct sealer paint to seal all the joints including elbows and seams. By ensuring that air is being delivered to, and exhausted from, occupied spaces in the manner in which the system was designed, the air quality of a home will improve and possibly reduce the volume of fresh air required to maintain good indoor air quality.

5.5 System Operation

1. Balanced Operation

The following clauses from the CSA installation standard pertain to this section.

CSA 326.2: 6.3.1.(g) - All procedures for start-up recommended by the manufacturer of the equipment, including air balancing and flow determination, shall be followed. As evidence that all start-up steps, including air balancing and flow measurements, have been done, the start-up mechanic shall complete and sign the pertinent section of a form similar to Form A, shown in Figure 1. Copies of the form shall be provided to the purchaser and others as appropriate.

CSA 326.2: 6.3.2 - The supply and exhaust flow rates in the normal ventilation mode shall be balanced so that the value of the lesser flow shall be at least 90% of the value of the greater flow, unless otherwise recommended by the manufacturer.

The HRV has been designed to operate most effectively and efficiently when the volume of air supplied to the house equals the volume of air exhausted from the house. Registered R-2000 houses are equipped with flow measuring stations (FMS) located in the warm side supply and exhaust flow ducts. The purpose of these FMS are to allow the installer to balance the HRV supply and exhaust flow rates to within 10% of the greater flow once the unit has been completely installed and is fully operational. Unfortunately, a number of problems can occur that result in false readings and unbalanced systems.

a) The FMS are installed in the wrong location in the duct and/or are installed backwards.
b) The FMS become contaminated with construction dust and dirt before the system is balanced.
c) The accuracy of the FMS is only $\pm$ 8% which means there is a potential error of 16% even if the installer has done a perfect job of balancing.

The field investigations indicated that the positioning of the FMS are critical. The manufacturer's instructions on positioning the FMS and on the balancing procedure are included in Appendix F.

2. Dehumidistat vs Humidistat Controls

It was originally believed that one of the advantages of an R-2000 house was the ability to maintain high humidity levels without the use of a humidifier. In Alberta, where winters are cold and very dry, this is not the case and homeowners usually must resort to free standing or power humidifiers to maintain comfortable humidity levels.

Operating a ventilation system and a humidifier, however, can result in problems. For example, if the humidistat setting on the humidifier is set higher that the dehumidistat setting of the HRV, the HRV will run on high speed in an attempt to lower house humidity levels to the dehumidistat setting, while the humidifier will continue operate in an attempt to attain the humidity level set with the humidistat.

To help the homeowner avoid this situation, the manufacturers should include information about these controls as part of a troubleshooting guide.

6.0 CONCLUSIONS

The heat recovery ventilation systems investigated during this study were installed during a period from 1985 to 1989. The problems encountered fell into two broad categories: problems associated with the components of the system, and those associated with system installation. Although the study was conducted only in Alberta, there are strong indications that the problems are more widespread.

Component problems are continually being addressed. The manufacturers of the Lifebreath and vanEE units investigated in this study have made significant improvements to their HRVs, HRV accessories and support documentation, and continue to address outstanding concerns raised during this investigation. Many of these improvements, however, will only be worthwhile if the system is properly installed.

Most of the ventilation system problems that occur, result directly from poor or incomplete installations carried out by unqualified tradespeople or contractors that do not have a clear understanding of ventilation principles and have not kept abreast of technical advancements in this field. If it is recognized and accepted that natural ventilation is not sufficient to ensure acceptable indoor air quality during the winter heating season, and if it is also recognized that proper ventilation will require expert installers and designers as well as knowledgeable inspection authorities, then education and training must become a greater priority within the industry.

In addition, if installation contractors are not ready to accept the responsibility of ensuring that their ventilation systems are properly installed, commissioned and capable of providing good indoor air quality, then steps must be taken by the proper authorities to regulate the installation of these systems.

Finally, as concerns are addressed, it is very important that a significant effort be made to provide the owners of existing ventilation systems with information that will allow them to verify the operation of their systems. This will, of course, require trained service personnel to address homeowner concerns.

7.0 SUMMARY OF RECOMMENDATIONS

All of the recommendations summarized below have been discussed in detail in Section 5, *Problem Areas and Recommended Solutions*. These recommendations are directed at the manufacturers who are producing HRVs and HRV accessories and at the groups, such as CSA, who are establishing ventilation requirements and issuing installation and compliance standards.

* It is recommended that a label with operation and service information be affixed to both the front panel on the outside of the unit and to the face of the core inside the unit. An alternative to an information label affixed to the outside panel would be a stick-on clear plastic envelope permanently attached to the front of the HRV containing the *Operating and Service Guide* and any other information required by the homeowner.

  NOTE: If an information label is not affixed to the core, some other method is essential to ensure that, when it is removed during installation or for servicing, it can be oriented properly when replaced.

* It is recommended that requirements for labelling on outdoor intake grills be expanded to include exhaust grills and require that these hoods remain accessible for maintenance. The manufacturers installation guide should also include this advisory so that these hoods do not become inaccessible due to the addition of structures such as a deck.

* It is strongly recommended that maintenance procedures be expanded to include the inspection of outside screens and interior exhaust registers. It is very important that the screen on the exterior fresh air intake hood be cleaned to keep it free of debris. In addition, it is recommended that, if a proper fastener can be located, the hinged screen be incorporated into all air intake weatherhoods.

* It is recommended that a procedure for verifying the operation of the supply and exhaust motors be included in the homeowner's service and maintenance guide. This can be easily done by holding a sheet of paper in front of each hood. If the motors are working, the exhaust air will blow the paper away from the hood while the fresh air intake will draw the paper into the hood.

* Nutech has an accessory available called an "oil telespout" which fits into the plastic oil spout installed on the HRV motor. The cost of this accessory is $5.00. It is recommended that information about the availability of this accessory be supplied to the homeowner.

* The vanEE *Service and Operating Guide* for the homeowner does not include instructions on verifying the operation of the damper motor and it is recommended that the homeowner guide be updated to include this information.

* The installation manuals for both the Lifebreath and vanEE units state that insulated flexible ducts should be used on both the intake and exhaust connections from the HRV to the outside. It is strongly recommended, however, that these manuals be changed to state that these products ***must*** be used and detail the serious consequences of not using them. Both manufacturers understand some of the serious consequences of this problem and have agreed to include these changes in subsequent installation guides.

* It is strongly recommended that factory settings be changed for units going to areas where winter temperatures drop below -25^{0}C. Based on past performance, the installer cannot be relied upon to make these adjustments in the field.

* Since the homeowner is the ultimate user of the ventilation system, each manufacturer should review their homeowner information package and ensure that complete information is provided in the following three areas:

  a) Operation of the HRV, including dehumidistat operation.

  b) Service and Maintenance, including a system checklist similar to those included in Appendix B and C.

  c) Troubleshooting, including information on who to contact in the event that additional questions arise.

* Training manuals should be updated with findings from this report to ensure that installers realize the problems that result from inadequate and incomplete installation practices and understand the consequences of failing to follow recommended installation procedures. This comment applies to the current HRAI training manual.

All of the above recommendations have been reviewed and approved by Nutech and CES. Many of the recommendations have already been incorporated into their manufacturing processes while the remainder are currently being addressed.

APPENDIX A:

Combustion Air Requirements

COMBUSTION AIR FOR DWELLING UNITS

This bulletin has been developed jointly by the Building Standards Branch and the Plumbing and Gas Safety Services Branch to clarify the requirements for combustion air for gas, oil and solid fuel (wood/coal) burning appliances that are installed within dwelling units.

The information provided relates only to the quantities and methods of providing combustion air for appliances and does not cover the quantities of air removed by mechanical ventilation systems that are also required to be provided for all dwelling units.

Other methods may be accepted - contact your local gas (for gas fired appliances) or building (for oil and solid fuel fired appliances) inspector for further information.

Fireplaces, Stoves, Space Heaters and Ranges Burning Solid Fuel

Combustion air must be supplied by one of the two following methods:

1. Directly to the fire chamber (for factory built appliances the units must be tested and listed with this feature and complete installation instructions are required). For fireplaces, glass doors are normally required in order for this method to be workable.

2. Directly to the room in which the appliance is located. This can be accomplished by installing a duct leading directly from outside the building into the room where the appliance is located. The duct should be as straight and short as possible and should have the same cross sectional area as the inside of the stovepipe (or chimney) that serves the appliance. A dampering mechanism is also required so that the duct may be closed when the appliance is not in operation.

Furnaces and Boilers

Appliance (fuel burned)	Area of Combustion Air Duct (based on input of all appliances in space)
Gas	CAN/CGA B149.1 CAN/CGA B149.2
Oil	CSA B139
Solid Fuel (example: wood and coal)	3300 mm^2/kW

All combustion air ducts should be as straight and short as possible. Normally no more than two elbows may be used unless the duct size is increased.

ISSUE OF THIS INTERPRETATION IS AUTHORIZED UNDER SENTENCE 1.5.4.2.(15) OF THE ALBERTA BUILDING CODE 1985 BY THE DIRECTOR OF BUILDING STANDARDS

D. O. MONSEN, M.R.A.I.C.

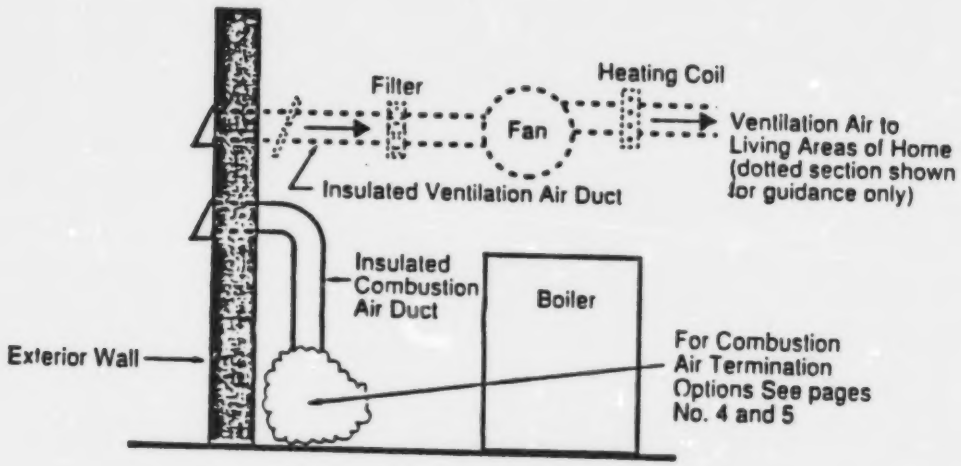
Alberta

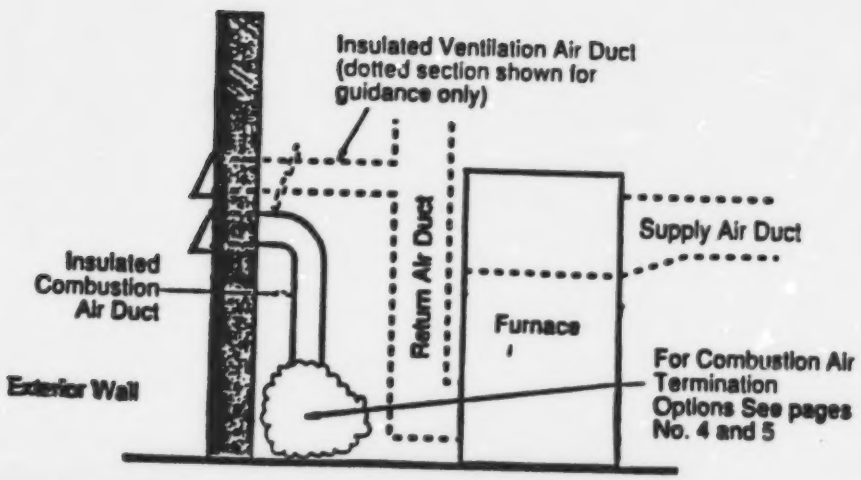
OIL AND SOLID FUEL FIRED FURNACES AND BOILERS

NOTE

The combustion air termination options shown on pages #4 and 5 will assist in the prevention of cold draughts on the floor within the general vicinity of the combustion air duct (in the past open ended combustion air ducts were often blocked off). It will also lessen the chance of water pipes (in the area below the combustion air duct) failing due to freezing temperatures (at least one option must be used).

* An air to air heat exchanger may be used for ventilation in lieu of fan/coil system shown.


Filter
Heating Coil
Fan
Ventilation Air to Living Areas of Home (dotted section shown for guidance only)
Insulated Ventilation Air Duct
Insulated Combustion Air Duct
Boiler
Exterior Wall
For Combustion Air Termination Options See pages No. 4 and 5


Insulated Ventilation Air Duct (dotted section shown for guidance only)
Supply Air Duct
Return Air Duct
Insulated Combustion Air Duct
Furnace
Exterior Wall
For Combustion Air Termination Options See pages No. 4 and 5

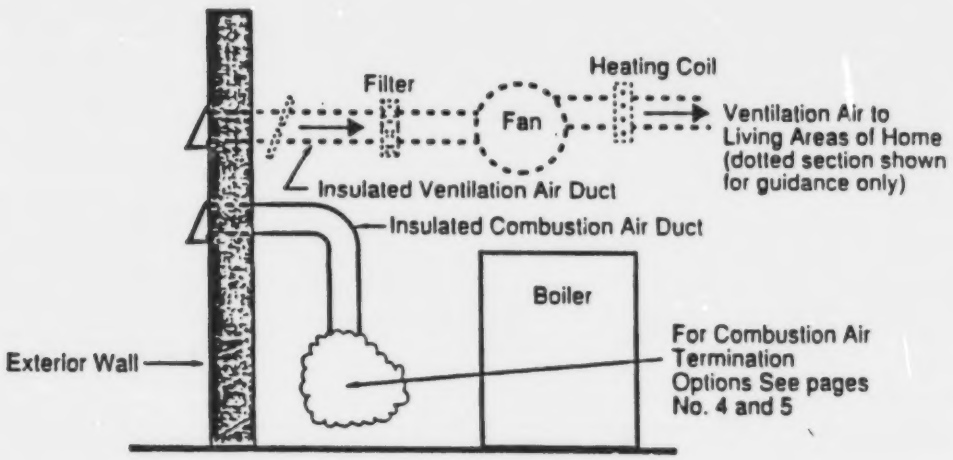
GAS FIRED APPLIANCES

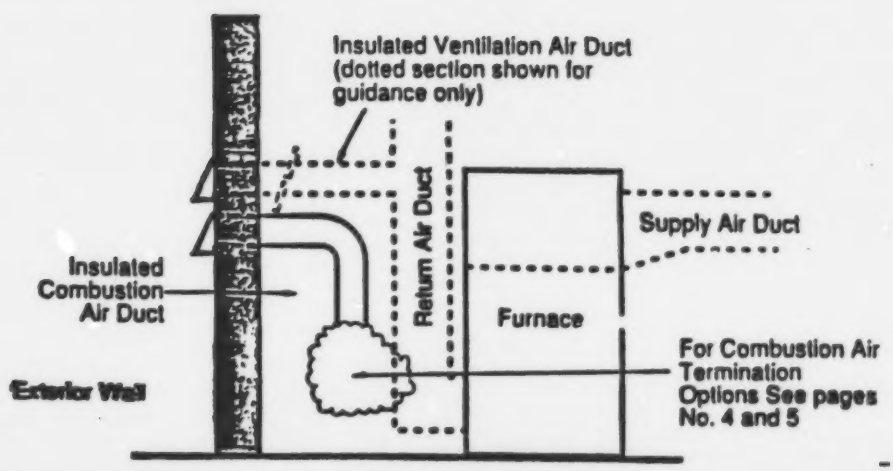
NOTE

The combustion air termination options shown on pages #4 and 5 will assist in the prevention of cold draughts on the floor within the general vicinity of the combustion air duct (in the past open ended combustion air ducts were often blocked off). It will also lessen the chance of water pipes (in the area below the combustion air duct) failing due to freezing temperatures (at least one option must be used).

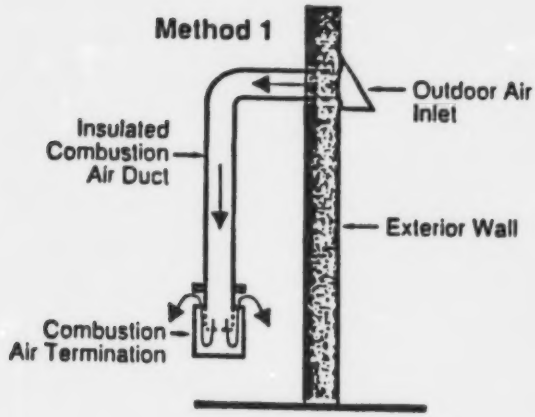
Combustion air must terminate within 300 mm above and within 600 mm horizontally from the burner level of the appliance having the largest input.

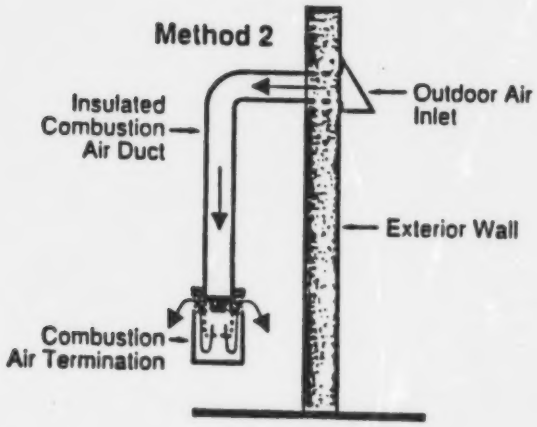
* An air to air heat exchanger may be used for ventilation in lieu of fan/coil system shown.

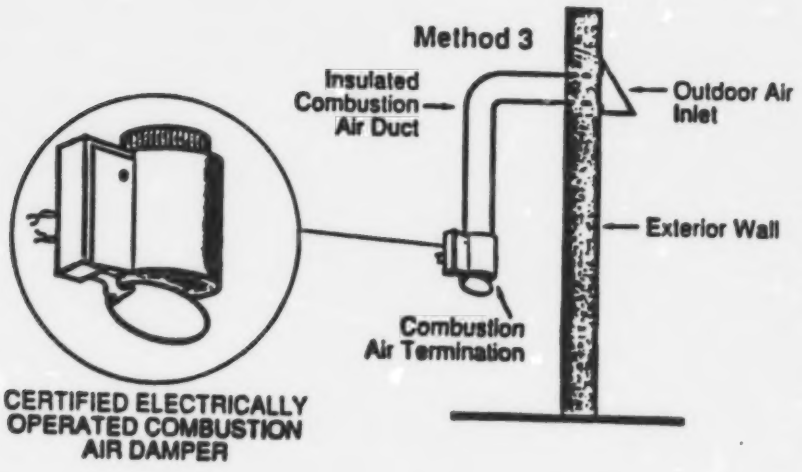

Filter
Heating Coil
Fan
Ventilation Air to Living Areas of Home (dotted section shown for guidance only)
Insulated Ventilation Air Duct
Insulated Combustion Air Duct
Boiler
Exterior Wall
For Combustion Air Termination Options See pages No. 4 and 5


Insulated Ventilation Air Duct (dotted section shown for guidance only)
Return Air Duct
Supply Air Duct
Insulated Combustion Air Duct
Furnace
Exterior Wall
For Combustion Air Termination Options See pages No. 4 and 5

COMBUSTION AIR TERMINATION OPTIONS FOR ALL APPLIANCES

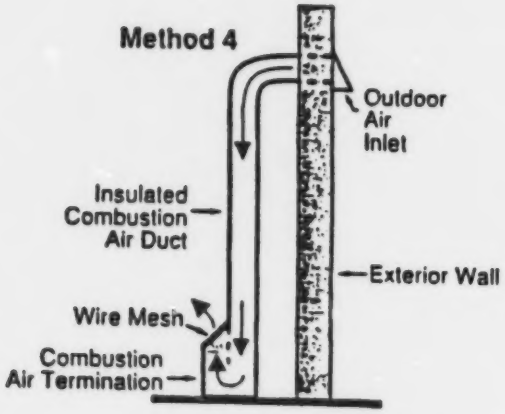


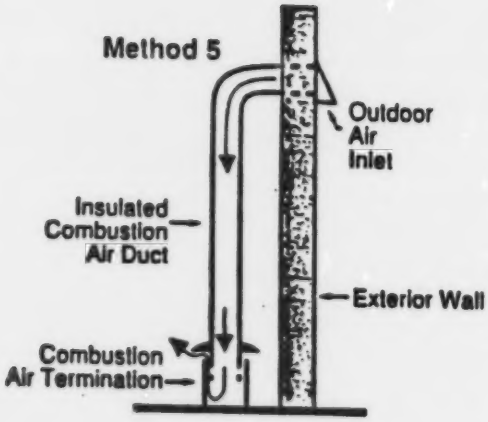




NOTE Other methods may be used provided they are accepted by the local building and gas inspection branches prior to installation.

Following combustion air terminations may be used for solid fuel or oil fired appliances. They may also be used for gas fired appliances if the termination point meets the B149 Code requirements of within 300 mm above and within 600 mm horizontally from the burner level of the appliance having the largest input.





NOTE 15 kW = 50,000 Btu/h (approx.)

APPENDIX B:

Homeowner Inspection Checklist

for

Lifebreath Heat Recovery Ventilators

LIFEBREATH EQUIPMENT INSPECTION CHECKLIST

Please read through the following checklist and carry out an inspection of your ventilation system. In addition, locate the operation and service guide that should have been supplied with your heat recovery ventilator (HRV) in order to familiarize yourself with the recommended operation and maintenance procedures.

Do you have the manufacturer's manual? Yes ____ No ____.

Inspect Exterior Duct Hoods and Verify Motor Operation

Two HRV duct hoods will be located on the exterior of the house to direct the flow of fresh air into the house and stale air out of the house. These hoods will be fairly large, since they are connected to a 6 inch duct, and should be about 6 feet apart. They usually have a piece of 1/4 inch wire screen which is meant to stop birds and animals from entering the duct work. It is this screen which can become plugged with debris and prevent proper airflows. Two motors located inside the HRV move air into, and out of, the HRV. On occasion, these motors have failed and it is a good idea to check that they are working.

In order to check the screen and verify that the motors are working, carry out the following steps.

1. If your HRV is off, turn it on and wait a few minutes for the defrost light (located below the on-off switch) to turn off.

2. Locate the two exterior duct hoods and note the following:

Approximate distance apart: _____ feet

Approximate height above ground: _____ feet

Comments: _____.

3. Check the 1/4 inch screen on each hood to see if they are plugged with debris and note the approximate percentage of plugging. The screen on the intake hood is the one that is usually plugged while the exhaust hood screen is relatively clean.

Fresh air intake hood: _____ % plugging

Exhaust air hood: _____ % plugging

Comments: _____.

4. Remove any debris from the screens.

5. Verify motor operation by checking the airflows through the exterior hoods. To do this, hold a sheet of paper (the checklist sheet could be used) in front of each hood. If the motors are working, the exhaust air will blow the paper away from the hood while the fresh air intake will draw the paper into the hood. As you have probably already noted, the intake hood was the one most plugged with debris.

Intake motor working: Yes ____ No ____.

Exhaust motor working: Yes ____ No ____.

Comments: _____.

Clean HRV Filters and Inspect Heat Exchanger Core

Inside the HRV, there should be two filters which collect the dust from the air streams which pass through the unit. These filters should be cleaned on a regular basis. In order to check these filters, carry out the following steps.

1. Turn the HRV off, and disconnect the power by unplugging the unit. The switch is located on the upper right-hand end.

2. Open the front panel of the ventilation unit. The Lifebreath typically has three clips located at the top of the panel which can be undone by hand. The front panel will swing down on pin hinges but BE CAREFUL - the door is removable and may drop if bumped off the pin hinges.

3. The units with one heat exchanger core have the two filters located on left hand side. The units with two cores have one filter on the left and one on the right hand side. Note the amount of dust that has collected on each filter.

Condition of filters: _____.

4. Remove and clean the filters by vacuuming them or running them under tap water. Vacuum inside the HRV if required.

5. Visually inspect the heat exchanger core(s) to ensure that they are not plugged. Vacuum them, if necessary, and note their condition below.

NOTE: If you remove the cores, be sure to orient them properly when they are replaced. The cores are not marked and can easily be put back in upside down or backwards. The drip edges are at the bottom of the core to direct the condensate into the drain pans.

Condition of core: _____.

6. Note the location of the defrost damper and damper motor inside the unit on the bottom left-hand side. In the next section, you will check to see if this motor is operating.

7. Replace the filters, close the front panel and plug in the HRV but DO NOT turn it on until you are ready to proceed to the next section.

Comments: _____.

Verify Operation of Defrost Damper Motor

When outdoor temperatures drop below approximately -8°C, the HRV automatically initiates a defrost mode to melt any icing that has occurred in the heat exchanger core. The operation of the defrost cycle depends on the damper motor that opens and closes the defrost damper inside the HRV. Several of these damper motors have failed in the field and it is important to ensure that the motor in your unit is working. In order to check the defrost damper motor, carry out the following steps.

1. Turn on the HRV.

2. Look up through the duct port located on the bottom left-hand side of the HRV. If the motor is working, the damper should rise completely to an upright position. The door should return to the down position in 2 to 4 minutes.

3. If the damper does not rise, shut the unit off and then the on again. If the damper still does not rise, the motor has to be replaced.

Defrost damper motor working Yes ____ No ____.

Comments: _____.

Verify Operation of Controls

The Lifebreath is typically equipped with 3 different speed control mechanisms:

1. a variable speed control located below the on-off switch;

2. a dehumidistat located to the right of the variable speed control; and
3. remote switches, usually located in the kitchen and bathrooms.

NOTE: There may also be a remote dehumidistat located on the main floor, usually near the thermostat.

Each of these controls should be checked to determine that they are functioning properly. In order to check these controls, carry out the following steps:

1. Note the current settings.

Variable speed setting: _____.

Dehumidistat setting: _____.

Comments: _____.

2. With the HRV running, turn off all remote switches in the bathrooms and kitchen.

3. Check that the defrost light below the on-off switch is off. If it is on, wait a few minutes until it goes off and the defrost damper is in the down position before continuing.

4. Rotate the variable speed knob to the slow speed position and then to the high speed position and note if the HRV fan speed increases.

Fan speed increases: Yes ____ No ____.

Comments: _____.

5. With the HRV fan speed set on low, rotate the dehumidistat knob until it is at its lowest setting, then slowly rotate the knob to the high end of the scale. The fan speed should have been high initially and then dropped to a lower speed when you raised the setting.

NOTE: If there is also a remote dehumidistat, each device should be checked separately. When checking one dehumidistat be sure the other one is on its highest setting.

Fan speed initially high: Yes ____ No ____.

Fan speed dropped down: Yes ____ No ____.

Comments: _____.

6. With the fan speed set on low and the dehumidistat set on high, have an assistant turn each of the remote switches on and off. Each switch should override the low speed setting and increase the fan speed.

Bathroom remote switches working: Yes ____ No ____.

Kitchen remote switches working: Yes ____ No ____.

Comments: _____.

7. Check the exhaust grills that will be located high on a wall in each of these rooms to ensure and clean if necessary.

Condition of exhaust registers: _____.

Comments _____.

Check Fresh Air Distribution and Duct Lines

It is essential that this fresh air be distributed to all the occupied areas of the house. In homes heated by a forced air furnace, the furnace fan is typically run on a continuous low speed and the fresh air is distributed by the furnace system. In radiant heated homes, the HRV is typically ducted to all rooms.

To ensure that air is effectively delivered to, and taken from, the rooms where the registers are located, the joints of ducts leading into, and out of, the HRV should be taped . In order to check the fresh air distribution and the duct lines, carry out the following steps:

1. Remove and check the furnace filter. Clean or replace it as necessary.

Condition of filter: _____.

Comments: _____.

2. Note the operation of the furnace fan.

Continuous low speed operation: Yes ____ No ____.

3. Follow the path of the fresh air duct from the HRV to the point where it is dumps the fresh air into the basement.

Fresh air point of entry into basement _____.

Comments: _____.

4. Visually check the HRV ducts that are not covered with insulation to see if the joints have been taped.

APPENDIX C:

Homeowner Inspection Checklist

for

vanEE Heat Recovery Ventilators

VANEE EQUIPMENT INSPECTION CHECKLIST

Please read through the following checklist and carry out an inspection of your ventilation system. In addition, locate the operation and service guide that should have been supplied with your heat recovery ventilator (HRV) in order to familiarize yourself with the recommended operation and maintenance procedures.

Do you have the manufacturer's manual? Yes ____ No ____.

Inspect Exterior Duct Hoods and Verify Motor Operation

Two HRV duct hoods will be located on the exterior of the house to direct the flow of fresh air into the house and stale air out of the house. These hoods will be fairly large, since they are connected to a 6 inch duct, and should be about 6 feet apart. They usually have a piece of 1/4 inch wire screen which is meant to stop birds and animals from entering the duct work. It is this screen which can become plugged with debris and prevents proper airflows. Two motors located inside the HRV move air into, and out of, the HRV. On occasion, these motors have failed and it is a good idea to check that they are working.

In order to check the screen and verify that the motors are working, carry out the following steps.

1. If your HRV is off, turn it on. If the defrost light is on, wait a few minutes until it turns off before proceeding.

2. Locate the two exterior duct hoods and note the following:

Approximate distance apart: _____ feet

Approximate height above ground: _____ feet

Comments: _____.

3. Check the 1/4 inch screen on each hood to see if they are plugged with debris and note the approximate percentage of plugging. The screen on the intake hood is the one that is usually plugged while the exhaust hood screen is relatively clean.

Fresh air intake hood: _____ % plugging

Exhaust air hood: _____ % plugging

Comments: _____.

4. Remove any debris from the screen.

5. Verify motor operation by checking the airflows through the exterior hoods. To do this, hold a sheet of paper (the checklist sheet could be used) in front of each hood. If the motors are working, the exhaust air will blow the paper away from the hood while the other hood, the fresh air intake, will draw the paper into the hood. As you have probably already noted, the intake hood was the one plugged with debris.

Intake motor working: Yes ____ No ____.

Exhaust motor working: Yes ____ No ____.

Clean HRV Filters and Inspect Heat Exchanger Core

Inside the HRV, there should be two filters which collect the dust from the air streams which pass through the unit. These filters should be cleaned on a regular basis. In order to check these filters, carry out the following steps.

1. Turn the HRV off and disconnect the power by unplugging the HRV. The switch is located to the right-hand side.

2. Open the front panel of the ventilation unit. The vanEE typically has three screws on the front that can be undone with a screw driver or the edge of a coin. The panel will swing down on pin hinges but BE CAREFUL - the door is removable and may drop if bumped off the pin hinges.

3. Locate the two filters on the left hand side of the unit and note the amount of dust that has collected on them. The vanEE 2000PLUS, which has two heat exchangers, will have three filters.

Condition of filters: _____.

4. Remove the filters and clean them by vacuuming or running them under tap water. Vacuum inside the HRV if required.

5. Visually inspect each heat exchanger core to ensure that it is not plugged. Vacuum it, if necessary, and note its condition below.

   NOTE: If you remove a core, be sure to orient it properly when it is replaced. The core has a label on the end of the core which faces to the outside. Ensure that the drip edges are at the bottom of the core to direct the condensate into the drain pans.

Condition of core: _____.

6. Replace the filters, close the front panel, plug in the HRV and turn it on.

Comments: _____.

Verify Operation of Controls

The vanEE is typically equipped with 3 different speed control mechanisms:

1. a variable speed control switch located on the HRV;
2. a dehumidistat mounted on the main floor, usually near the thermostat; and
3. remote switches, usually located in the kitchen and bathrooms.

Each of these controls should be checked to determine that they are functioning properly. In order to check these controls, carry out the following steps:

1. Note the current settings.

Variable speed setting: _____.

Dehumidistat setting: _____.

Comments: _____.

2. With the HRV running, turn off all remote switches in the bathrooms and kitchen.

3. Check that the defrost light on the HRV is off. When it is on, the unit is automatically switched to high speed. If it is on, wait a few minutes until it goes off before continuing.

4. Rotate the variable speed knob (located to the right hand side of the unit) to the slow speed position and then to the high speed position and note if the HRV fan speed increases.

Fan speed increases: Yes ____ No ____.

Comments: _____.

5. With the HRV fan speed set on low, have an assistant rotate the dehumidistat knob until it is at its lowest setting, then slowly rotate the knob to the high end of the scale. The fan speed should have been high initially and then dropped to a lower speed own when you raised the setting.

Fan speed initially high: Yes ____ No ____.

Fan speed dropped down: Yes ____ No ____.

6. With the fan speed set on low and the dehumidistat set on high, have an assistant turn each of the remote switches on and off. Each switch should override the low speed setting and increase the fan speed.

Bathroom remote switches working: Yes ____ No ____.

Kitchen remote switches working: Yes ____ No ____.

Comments: _____.

7. Check the exhaust grills that will be located high on a wall in each rooms with a remote switch and clean them if necessary.

Condition of exhaust registers: _____.

Comments: _____.

Check Fresh Air Distribution and Duct Lines

It is essential that this fresh air be distributed to all the occupied areas of the house. In homes heated by a forced air furnace, the furnace fan is typically run on a continuous low speed and the fresh air is distributed by the furnace system. In radiant heated homes, the HRV is typically ducted to all rooms.

To ensure that air is effectively delivered to, and taken from, the rooms where the registers are located, the joints of ducts leading into, and out of, the HRV should be taped . In order to visually check the fresh air distribution and the duct lines, carry out the following steps:

1. Remove and check the furnace filter. Replace if necessary.

Condition of filter: _____.

Comments: _____.

2. Note the operation of the furnace fan.

Continuous low speed operation: Yes ____ No ____.

3. Follow the path of the fresh air duct from the HRV to the point where it enters the basement.

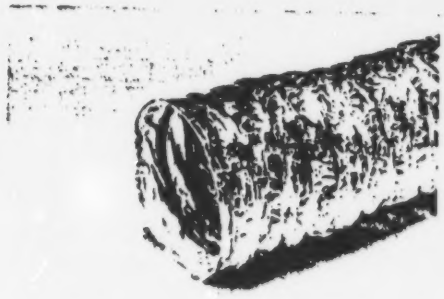
Fresh air point of entry into basement _____.

4. Visually check the HRV ducts that are not covered with insulation to see if the joints have been taped.

APPENDIX D:

Insulated Ducting Systems

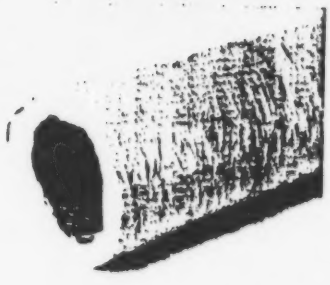
Flexible Ducting Systems



NFX 10

Description: FOIL NON-INSULATED UL 181 CLASS 1 CONNECTOR.
Construction: Multiplies of aluminum foil/polyester laminate and metalized polyester film encapsulating a steel wire helix.

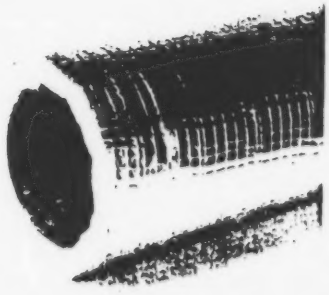
PERFORMANCE DATA
Temperature Range: −20°F to 180°F
Working Pressure: 6" w.g. pos., all dia.; 3/4" w.g. neg., all dia.
Velocity: 5,000 FPM
Standard Diameters: 3"-20"



NFX 20

Description: UL 181 CLASS 1 CONNECTOR PRODUCT FOR GENERAL PURPOSE USE.
Construction: Double lamination of tough polyester encapsulates a steel wire helix; high density fiberglass insulation; and sheathed in a durable polymer vapor barrier.

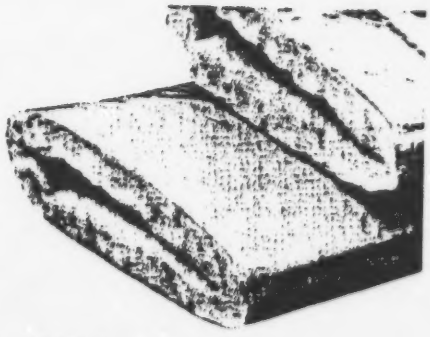
PERFORMANCE DATA
Temperature Range: −20°F to 250°F intermittant (½" pos. w.g. max.), −20°F to 180°F continuous (2" pos. w.g. max.), −20°F to 140°F continuous (max. pressure)
Working Pressure: 4" w.g. pos., 4"-10" dia.; 2" w.g. pos., 12"-20" dia.; 3/4" w.g. neg., all dia.
Velocity: 5,000 FPM
R Value: 5.79
Standard Diameters: 4"-20"



NFX 30

Description: QUALITY LEADER WITH REINFORCED METALIZED VAPOR BARRIER PROVIDES HIGHEST THERMAL PROPERTIES, UL 181 CLASS 1 DUCT.
Construction: Double lamination of tough black polyester encapsulates a steel wire helix for the core; high density fiberglass insulation; and a metalized spirally reinforced vapor barrier.

PERFORMANCE DATA
Temperature Range: −20°F to 250°F intermittant (½" pos. w.g. max.), −20°F to 180°F continuous (2" pos. w.g. max.), −20°F to 140°F continuous (max. pressure)
Working Pressure: 6" w.g. pos., 4"-12" dia.; 4" w.g. pos., 14"-20" dia.; 3/4" w.g. neg., all dia.
Velocity: 5,000 FPM
R Value: 6.0
Standard Diameters: 4"-20"



NFX 60

Description: LABOR SAVING 5' PIPE SLEEVES
DATA
10 Series: Energy-efficient 1¼" fiberglass blanket insulation encapsulated in a metalized vapor barrier, provides an R value of 5.79 and vapor transmission of .05 perms.
11 Series: Tough polyethylene vapor barrier encloses 1" fiberglass insulation blanket to provide an R value of 4.3 and vapor transmission of .10 perms.

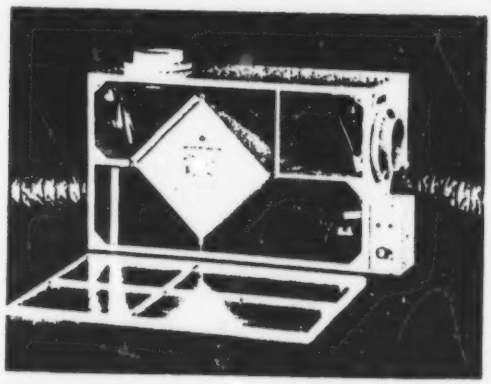
Packaging: 4"-12" diameter, 20 pieces per carton; 14"-16" diameter, 10 pieces per carton. Starter cap is enclosed with each carton of pipe sleeve.

2000 Series *Central Heat Recovery Ventilator*

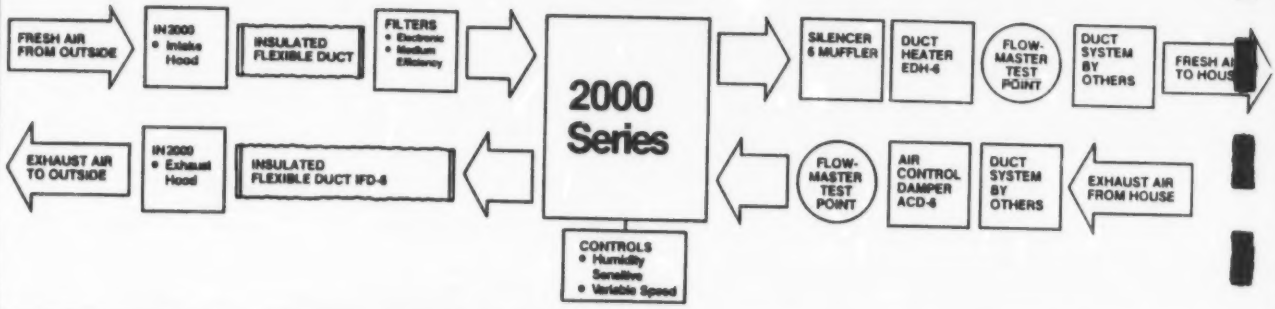
The vanEE 2000 Series Heat Recovery Ventilator is a centralized system for whole-house ventilation. Its unique single cross-flow removable core provides up to 80% temperature recovery at 100 cfm (47 L/s). The exclusive FrostBuster™ Defrost System offers efficient, reliable, and low cost operation in even the coldest areas of North America.

With a typical fully ducted system (.4 in/$H_2$0 external), up to 225 cfm (106 L/s) is available to meet most residential requirements.

Refer to TIS-04 for full technical data.



2000 Series System Design



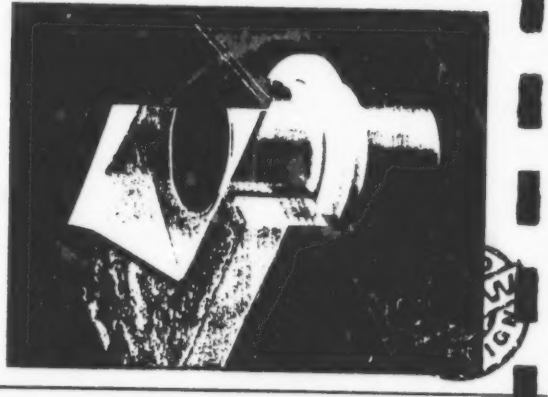
IN2000 *Installation Kit*

Another problem solver exclusively from vanEE —

The all new IN2000 offers unique features:

- 2 separate components which telescope to fit different wall thicknesses.
- A guaranteed air seal between the vapour barrier covering of the duct and the building.
- Low restriction hood with self-storing screen.
- Pre-finished galvanized hoods.
- Hoods may be removed to allow siding or other exterior work to proceed without disturbing flexible insulated duct.

Refer to T1S-13 — For full technical data.



Insulated Flexible Duct *(IFD-6)*

The vanEE IFD-6 is a Class 1, UL181 rated duct utilizing a polymeric duct liner, permanently bonded to a coated steel wire helix. A fiberglass blanket rated at R4.347 is enclosed in a continous vapour barrier. The IFD-6 is recommended for connecting the fresh air supply and exhaust to outside ports of the heat exchanger to the intake and exhaust hoods.

The IFD-6 is conveniently boxed in 25' (7.6m) lengths.

Refer to T1S-13 — For full technical data.

APPENDIX E:

Instructions for Adjusting the Lifebreath Defrost Timer

LIFEBREATH™
CENTRAL VENTILATION SYSTEMS

Customer Service Bulletin

ADJUSTMENT OF DEFROST TIMER FOR OPERATION TO -40°C
(MODELS 100 DEF, 200 MAX, 195 DCS AND 300 DCS)

02-03-89 **TD-00102**

The defrost mechanism on the above listed models is factory pre-set for proper operation at -25 degrees Celsius. However, we have had several requests for information regarding adjustment of the defrost timer for operation in areas where the temperature drops substantially lower than this. Before making these adjustments it is important to check the following conditions:

1.) The unit must have a proper air flow balance. Unbalanced flow rates between the supply and exhaust streams may hinder the machine's ability to defrost properly.

2.) Check the average temperature of the room where the unit is installed. It must be above 18°C (65°F) at all times to contain enough energy to defrost the cores in the 2 1/2 minute defrost interval the timer is factory set at. If the temperature of the defrost air is below 18°C, a six inch duct should be run from the defrost port on the HRV to a grill located in a warmer area of the house.

If the cores still freeze up after these checks and/or changes, the following adjustment can be made to the timer circuit board.

BEFORE MAKING THIS ADJUSTMENT, CALL NUTECH ENGINEERING COLLECT AT (519)-686-0797 TO VERBALLY CONFIRM THIS ADJUSTMENT.

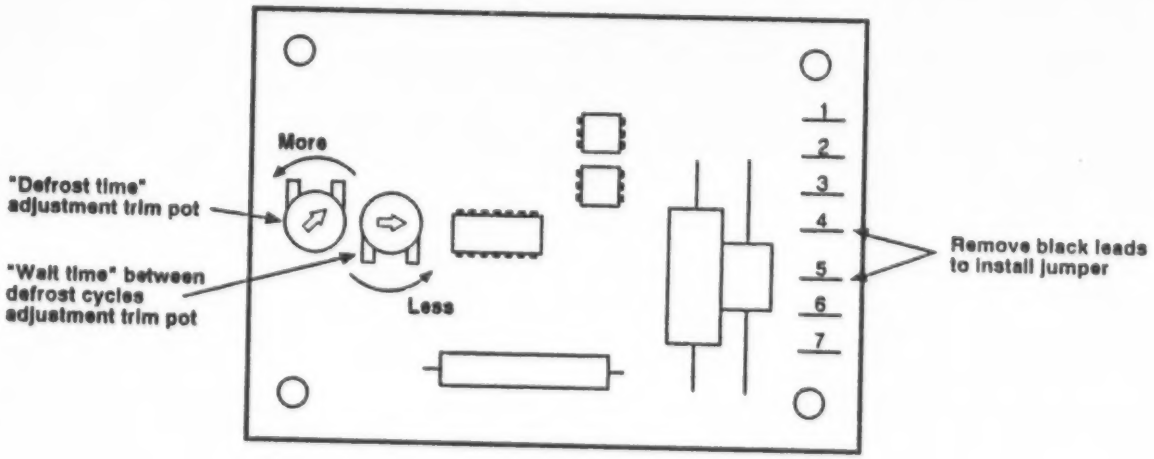
NOTE: This adjustment should only be made by qualified service personal as potentially dangerous line voltage (120 VAC) may be present while the electrical box cover is removed. Follow the instructions carefully to prevent the risk of electrical shock. Unplug the unit while working inside the electrical box.

1.) Unplug the unit. Remove the electrical cover.
2.) Turn the "DEFROST TIME" Adjustment Trim Pot fully counterclockwise (see accompanying illustration on back of this page). This will result in an approximate five minute defrost time which should be more than adequate for -40 degrees Celsius temperatures.
3.) Plug in and turn on the unit, measuring the length of time the defrost light stays on to confirm that you made the adjustment correctly.
4.) Replace the electrical cover.

If, after several days, the unit still experiences "core freeze-up" (note: just prior to a defrost cycle, a little frost is normally visible on the cores) after making the above adjustment then call Nutech engineering once again (collect) to report observations. You may then be instructed to perform the the following "time consuming" adjustment.

Continued on next page...

1.) Unplug the unit. Remove the electrical cover.
2.) Remove the two BLACK leads from pins 4 and 5 on the timer circuit board using extreme care not to loosen the "Fast-on" tabs. Wrap electrical tape on the ends of the leads to prevent short circuits.
3.) Install a jumper lead between pins 4 and 5.
4.) Turn the "WAIT TIME BETWEEN DEFROST CYCLES" Adjustment Trim Pot counterclock wise a very small amount (10 degrees).
5.) Plug in the unit and turn it on. Wait for the defrost test cycle to complete and, using a stopwatch, measure the time interval until the defrost indicator relights.
6.) Repeat steps 4 and 5 until a wait time of 19-21 minutes is achieved.
7.) Remove the jumper and reinstall the two black leads on pin 4 and 5.
8.) Install the electrical cover.



Application Warning

It is always important to assess how the operation of any Heat Recovery Ventilator (HRV), may interact with vented combustion equipment. (ie., Gas Furnaces, Oil Furnaces, Wood Stoves, etc.)

NEVER install an HRV in a situation where its normal operation, lack of operation or partial failure may result in the backdrafting or improper functioning of vented combustion equipment!

NUTECH ENERGY SYSTEMS INC.

124 Newbold Court
London, Ontario
N6E 1Z7

Phone: (519) 686-0797 Fax: (519) 685-9800

APPENDIX F:

Flow Station Positioning and Balancing Procedures

Balancing Procedure

FlowMaster™

Only one method of flow balancing is recommended by vanEE, the same method as approved by the R2000 Housing Program—The vanEE FlowMaster™.

The vanEE FlowMaster™ is also one of the simplest, error free and inexpensive air flow balancing and measuring systems available.

It is available from all vanEE distributors at a very reasonable price. Some distributors make kits available for loan or rental.

Balancing Importance

It should be pointed out that airflow balancing is very important to proper operation of the heat recovery ventilator. If the supply air from outside is greater than exhaust air from the house, the imbalance can result in the core of the HRV freezing up. If the exhaust air from the house is greater than the supply air from outside combustion appliance backdrafting may bring exhaust fumes into the house. A balanced condition will ensure optimum performance, provide satisfied customers and avoid expensive callbacks.

Note: Before proceeding with balancing, the house should be tightly closed (all windows, doors), and NO exhaust systems (dryers, range top exhausts) should be in operation. The forced air furnace, if used for circulation, should be operating at its continuous operating speed. Measure the exhaust air first as it is often the lowest due to a longer ductwork system.

The connection between the flow grid and the ductwork must be sealed with tape. See next section "Flow Station Positions".

With the speed control at maximum, connect the hoses from the flow station (grid) to the magnahelic gauge. The gauge must be level and zeroed before use to read accurately.

If the needle falls below zero, reverse the hose connections.

Ensure that the volume damper is wide open. Take a reading from the magnahelic and record it. Remove the flow station (grid) and place it in the supply duct. (Not necessary to move grid if permanently mounted. See next section "Flow Station Positions".)

Repeat the procedure. If the reading is higher than the exhaust reading, adjust the damper until the reading is the same. If the reading is lower, return the grid to the exhaust duct and adjust the exhaust damper to obtain the same reading.

Note: It is important to ensure the HRV is balanced at the time of installation and following future house renovations and mechanical system changes which may affect the HRV airflow balance.

VARI-quiet™ Adjustment

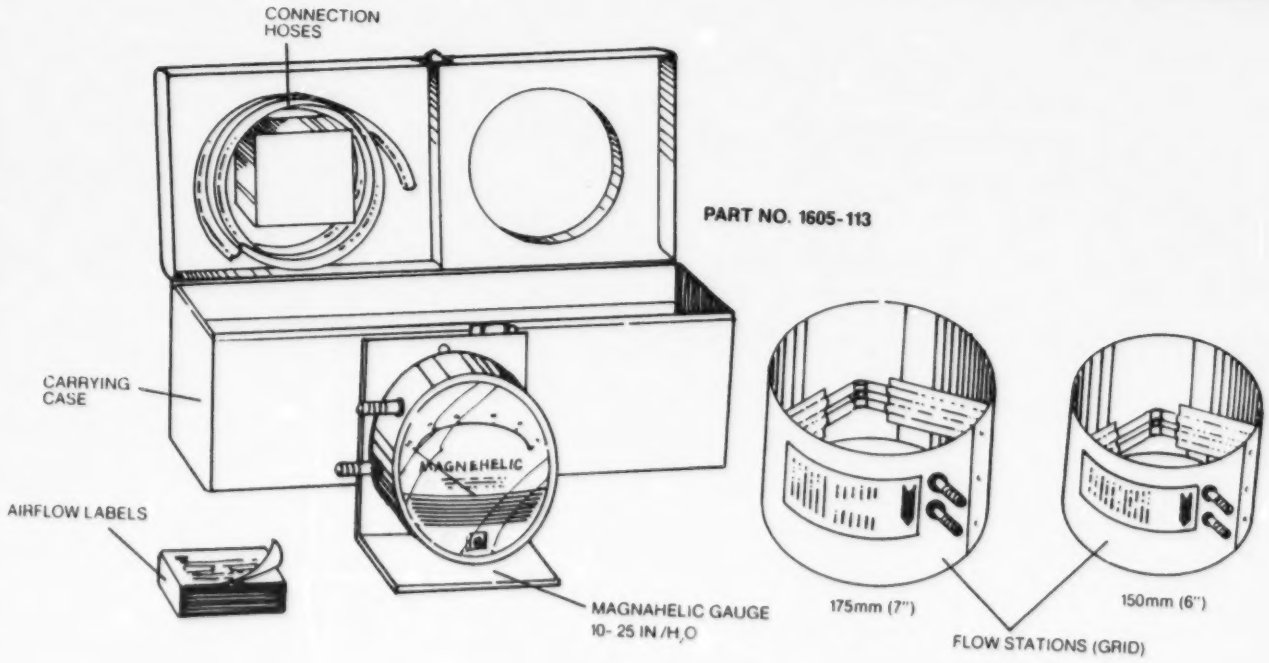
The VARI-quiet™ speed control should now be adjusted to provide the minimum, continuous ventilation rate as determined in the "Ventilation Requirements Guideline" at the beginning of this manual.

During the adjustment procedure, the switch on the control panel of the HRV must be in the "MED" (NORMAL) position. Each time the VARI-quiet™ requires adjustment, the unit should be unplugged to ensure there is no power on the resistor during adjustment. At no time should the sliding ring on the resistor be moved while power is being applied to the unit.

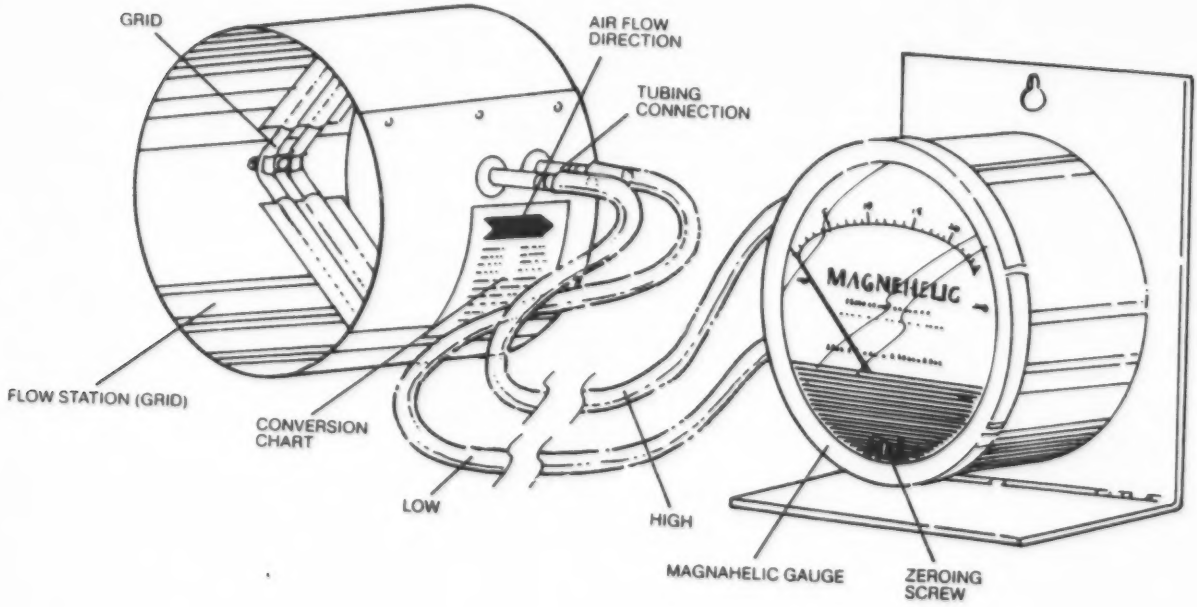
A label with the date, maximum and continuous balanced air flows, and the installer's name and phone number should be attached for future reference by the homeowner. Self-adhesive labels are supplied with each FlowMaster™ kit.

See the accompanying drawings for more detail.

Flow-Master™ Kit



Magnehelic Connections



Flow Station Positions

Permanent Flow Stations

Whether flow stations are permanently installed or used temporarily when using the FlowMaster™ Kit the position they are placed in is very important to ensure accuracy.

The best locations for mounting air flow measurement stations are in long straight sections of ducting where air flow has stabilized across the area of the duct. This will provide the most accurate measurements.

The next best location for airflow measuring stations is immediately before or after a 90 degree elbow, and 300mm (12") from any damper. In straight sections of pipe the measuring station should be installed at least 760mm (30 inches) from any fan outlet. This applies to the Fresh Air Supply to Building connection on the HRV.

With air flow stations permanently installed balancing is done by measuring air flow on one side of the HRV and then on the other. Adjustments can then be made to the damper(s) to equalize air flows.

Temporary Flow Stations

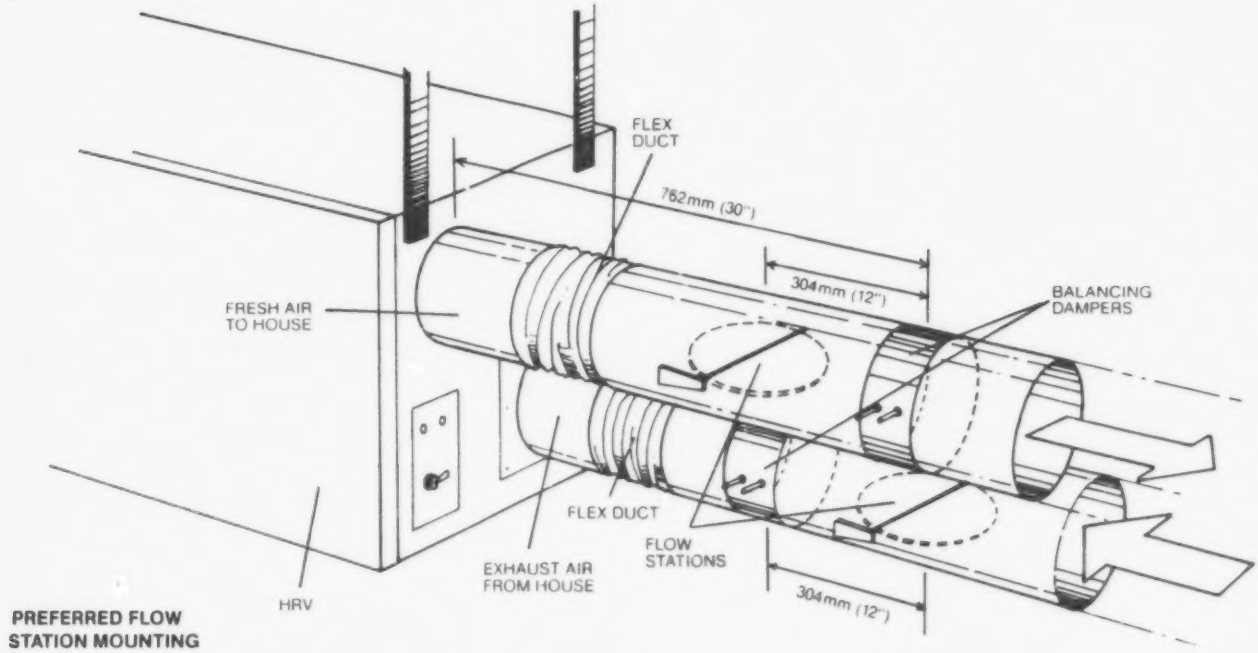
When using the temporary method a flow station is mounted in one air duct of the HRV and the air flow recorded. The flow station is then relocated to the other air duct, and air flow is recorded again. Dampers can then be adjusted to equalize air flow. The procedure should be repeated to ensure the unit is balanced properly.

The flexible connectors supplied with the unit can be located at locations suitable to measure air flow. It should be remembered that the longer section of flex duct should be located on the exhaust from house collar to allow future service of the exhaust blower.

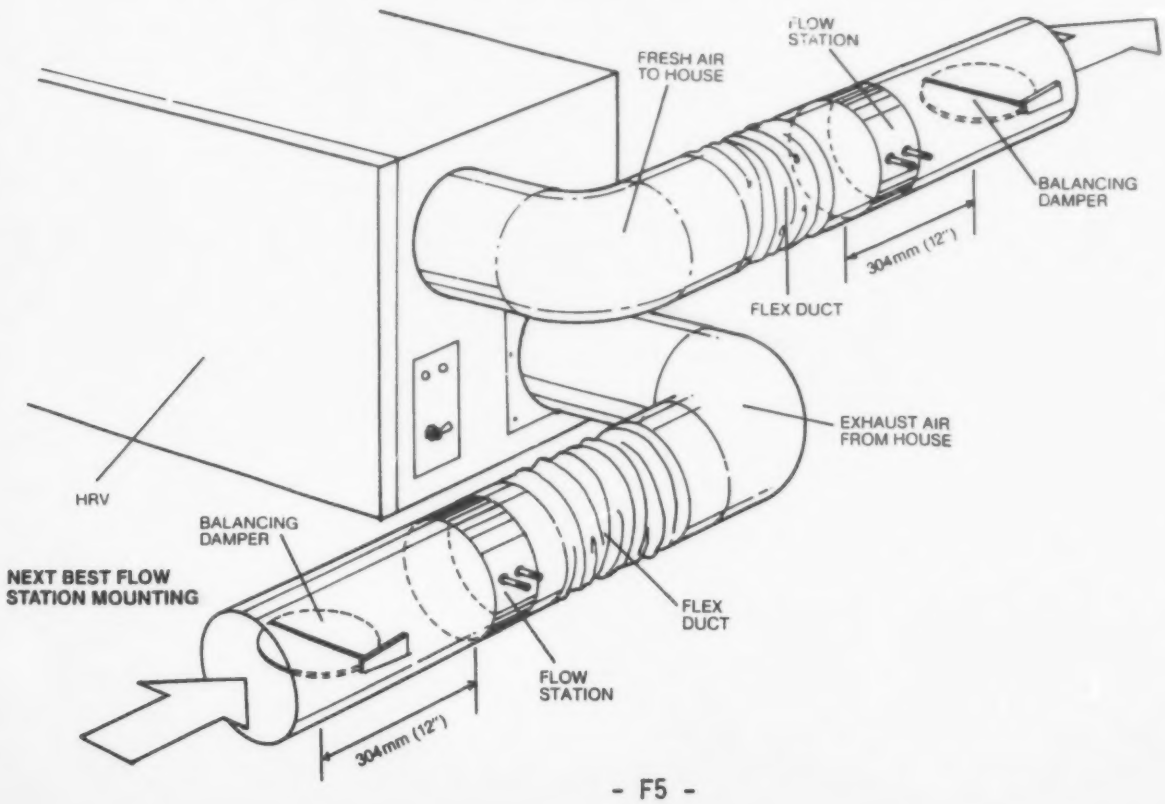
Always try to locate flow measuring stations in the straightest sections of duct to ensure accuracy.

VanEE manufactures a complete range of FlowMaster™ stations starting at 100mm (4") diameter. For larger duct diameters or other HVAC applications contact your vanEE representative.

Flow Station Position



PREFERRED FLOW STATION MOUNTING



NEXT BEST FLOW STATION MOUNTING